Engineering Library

JAN 11 1944

The Engineer

VOL. CLXXVI—No. 4586 28, ESSEX ST., STRAND, LONDON, W.C.2 DECEMBER 3, 1943

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper

In this Rotol constant-speed propeller, each blade sets up a centrifugal load of more than 50 tons, plus heavy tilting and journal loads due to thrust, inertia and gyroscopic effects.
Specially developed Timken tapered roller bearings, with their line contact and higher load capacity, carry these complex thrust and journal loads with freedom of action and positive rigidity.
BRITISH TIMKEN LTD., BIRMINGHAM, 7
TIMKEN

DON'T SIT ON your redundant POWER PRESSES

& SHEET METAL WORKING MACHINERY

They are wanted for work in... the ***NATIONAL INTEREST***

Offer them to

...GEORGE COHEN

SONS & COMPANY LTD

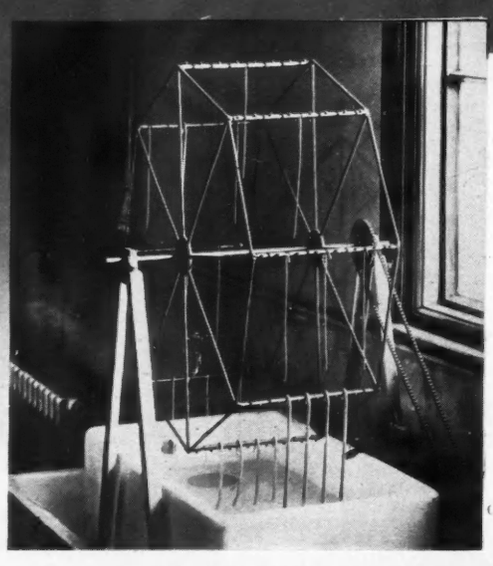
SUNBEAM ROAD • PARK ROYAL • LONDON • N.W.10

Telephone : WILLESDEN 0944 Telegrams : OMNITOOLS, HARLES, LONDON

ONE OF THE 600 GROUP OF COMPANIES

AND AT: LEEDS BIRMINGHAM SHEFFIELD MANCHESTER SOUTHAMPTON BATH SWANSEA NEWCASTLE Etc. ESTABLISHED 18

BRYANISING *The last word in Galvanizing*



THE DIPPING TEST

Nothing is good or bad except by comparison. In the test illustrated, lengths of **BR**yanised (Electro-Galvanized) Wire, together with lengths of Hot-galvanized Wire, are attached to a wheel making two revolutions an hour. The Wires are dipped in and out of a solution of synthetic Sea-water plus ½% Hydrochloric Acid to accelerate Corrosion.

When the Coating of Hot-galvanized Wire is showing signs of serious Corrosion the condition of the **BR**yanised Wire is still almost perfect.

This test proves that—

BRyanising provides the strongest possible defence against Corrosion.

BRITISH ROPES LIMITED

MANUFACTURERS OF WIRE • WIRE ROPES & HEMP CORDAGE HEAD OFFICE • DONCASTER • Offices & Works Throughout Gt. Britain

The Engineer

LONDON, FRIDAY, DECEMBER 3, 1943.

PUBLIC NOTICES

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD

ACCOUNTANT

Applications are Invited by the NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD for the POST of ACCOUNTANT. Applicants must have had previous experience with an Electricity Supply Undertaking. Arrangements for the adoption of a Superannuation Scheme for the Board's staff are under consideration.

Applicants should give full details of qualifications, education, training, and subsequent experience, and state present salary. The final date for the receipt of applications is 10th December, 1943.

Applications should be addressed to the SECRETARY TO THE BOARD, c/o SCOTTISH HOME DEPARTMENT, ST. ANDREW'S HOUSE, EDINBURGH, 1. 8644

BRITISH GEAR MANUFACTURERS' ASSOCIATION

This Association Has Now been formed, and a cordial INVITATION to JOIN is extended to all Manufacturers of Machine-Cut Gears and Enclosed Gear Drives; also to Manufacturers of Machines or Tools for Cutting Gears.—A Brochure and application form may be had from the CHAIRMAN, BRITISH GEAR MANUFACTURERS' ASSOCIATION, WELLINGTON HOUSE, STRAND, LONDON, W.C.2. 8650

LONDON COUNTY COUNCIL

LECTURER IN MECHANICAL ENGINEERING

Full-Time Lecturer in Mechanical Engineering of Degree standard for National Certificate Courses, &c., required at South-East London Technical Institute, Lewisham Way, S.E.4. The appointment is temporary, subject to review at any time and in any event at the end of the war. May lead to permanency.

Salary, Burnham Technical Scale for Graduates, rising by £15 to £529, plus war bonus (at present £100 per annum). Incremental allowances made for industrial and/or teaching experience.

Application forms (T1/40) obtainable from the EDUCATION OFFICER (T1), THE COUNTY HALL, WESTMINSTER BRIDGE, S.E.1 (stamped addressed foolscap envelope necessary), to be returned by 13th December, 1943. 8645

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF ASSISTANT LECTURER IN MECHANICAL ENGINEERING

The Governing Body Invites APPLICATIONS for an ASSISTANT LECTURESHIP in MECHANICAL ENGINEERING in the College of Technology, with the title and status of Assistant Lecturer in the University of Manchester.

Salary, £300 per annum, rising by annual increments of £25 to £400 per annum.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester, 1. The last date for the receipt of applications is 31st December, 1943.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS,
Principal of the College.

8635

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

ASSOCIATION of MANUFACTURERS REQUIRES MANAGER for work chiefly in connection with Publicity. Knowledge of Mechanical and Hydraulic Engineering essential. Salary £750 to £1000 per annum.—Write, Box [illegible], c/o Foster Turner, 11, Old Jewry, London, E.2. 8651 A

DEPARTMENTAL WORKS MANAGER WANTED for Structural, General, and Machine Shops, N.E. London district; previous experience in similar capacity and control of skilled labour.—Address, 8570, The Engineer Office. 8570 A

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE

ARRANGED FOR CARD INDEXING

(TABLE OF CONTENTS, PAGE 446)

Salvage of U.S.S. "Lafayette"—No. III (P. 440)
THE ENGINEER, 3 - 12 - 43

Engineers and the British Empire
No. XXII (P. 439)
(C. A. M. SMITH) THE ENGINEER, 3 - 12 - 43

Life and Work of Nikola Tesla (P. 447)
(DR. FLEMING) THE ENGINEER, 3 - 12 - 43

New Method of Sorting Steels (P. 442)
(BROWN & BRIDLE) THE ENGINEER, 3 - 12 - 43

Gyroscopic Principles and Applications
No. II (P. 452)
(C. E. INGLIS) THE ENGINEER, 3 - 12 - 43

High-Pressure Superimposed Power Plant
No. I (P. 450)
THE ENGINEER, 3 - 12 - 43

Quest for Economy (P. 446)
THE ENGINEER, 3 - 12 - 43

SEE PAGE 9

INDEX TO ADVERTISEMENTS, PAGE 55

THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1941 No. 2069

RESTRICTION ON ENGAGEMENT ORDER

WANTED, MANAGER for Repetition Iron and Non-Ferrous Foundries, to Take Control and Improve Output and Reduce Defectives and Develop on Modern Lines for an Old-Established Engineering Works in South Midlands with good post-war prospects. State age, experience, and salary required, and when free to take up duties.—Address, 8643, The Engineer Office. 8643 A

GENERAL MANAGER REQUIRED for Large Engineering Works. Should be qualified Engineer with experience of Modern Production Methods. Commencing salary not less than £1500.—Address, stating age, education, training, and particulars of positions held with salaries, P6490, The Engineer Office. P6490 A

SITUATIONS OPEN

GOOD FACTORS CONSIDERED Some Districts for Sale of following Products: Leather Vee Ropes, endless or with fasteners; Vee Rope Pulleys; Conveyor Belts.—Write in first instance, BENSON VEE LEATHER CO., Ltd., Longside Lane, Bradford. P6472 A

MANAGER, Engineering, REQUIRED, to Take Charge of Technical and Production Control. Permanent post on work of national importance; excellent assured post-war situation. Requirements: Good General and Technical Education, Tool Room and Staff Control experience. Applications, which are confidential, must include full details of qualifications, age, positions held, salaries received.—Address, 8646, The Engineer Office. 8646 A

MECHANICAL ENGINEER REQUIRED for permanent POST on work of national importance. Requirements: Excellent general and technical education, apprenticeship, and executive experience covering large-scale production. Salary £1000 p.a., with rapid advancement to suitable man. Applications, which are confidential, must include full details of qualifications, age, positions held, and salaries received.—Address, 8595, The Engineer Office. 8595 A

SITUATIONS OPEN

MANAGER REQUIRED, with Experience of Production of Electrical Components, preferably relative to Radio Industry. Must have had experience of Organisation and Control.—Address, giving details of training, experience, references, age, and salary required, 8633, The Engineer Office. 8633 A

MANAGER REQUIRED, with Previous Experience in Manufacture of Diesel Engines and Allied Industries. Applicants must have had previous experience, with good Organising Ability.—Address, giving details of training, experience, references, age, and salary required, 8632, The Engineer Office. 8632 A

MANAGER (Qualified Metallurgist) REQUIRED for Metallurgical Research Section of large organisation in London district manufacturing Aircraft and other Scientific Instruments. State qualifications, experience, and salary required.—Address, 8605, The Engineer Office. 8605 A

NON-FERROUS METALS. — MANAGING DIRECTOR SEEKS IMMEDIATELY qualified ASSISTANT, experienced Works and Production Management; progressive position of importance in large public company, modern plant; position offered is permanent for right man, with post-war prospects; first-class references, all-round experience, tact, and energy essential; age 35 to 45; London area; salary commensurate with position.—Typewrite full details, age, experience, salary required to Box 389, c/o Pool's, Aldwych House, London, W.C.2. 8630 A

SALES ENGINEER ASSISTANT WANTED, by Controlled (E.W.O.) firm; must be good Technical Correspondent, with engineer training in Structural and Fabricated Products.—Write, full details, COMMERCIAL STRUCTURES, Ltd., Staffa Works, Leyton, E.10. 8566 A

STOREKEEPER WANTED, Engineering Firm in North-West London district; permanent position for right man.—Write, Box 373, c/o Streets, 8, Serle Street, London, W.C.2. 8622 A

THE Post You Are Seeking May Not Be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

WE Are LOOKING for a MAN Who Has Specialised in the Manufacture and Sale of a Product suitable for Keeping Well-Equipped Woodworking Plant and Light Engineering and Sheet Metal Works Busy after the War. Preparatory work as soon as possible. Both plants employ several hundred people, and right man will be adequately rewarded. Replies should indicate the nature of the proposition, be marked "Principal," and will be treated as confidential.—Write, Box No. 829, c/o Dorland, 18, Regent Street, S.W.1. 8649 A

WELL-ESTABLISHED ENGINEERING FIRM in Leicestershire REQUIRES TECHNICAL OFFICE MANAGER, able to decipher Blue Prints. Good position for suitable applicant.—Address, stating age, experience, and salary required, P6474, The Engineer Office. P6474 A

SITUATIONS WANTED, Page 2

AUCTIONEERS & VALUERS, Page 56

BUSINESSES and PREMISES For Sale, &c., Page 56

FOR SALE, Pages 4 and 56

FOR HIRE, Page 2

EDUCATIONAL, Page 4

AGENCIES, Page 2

PATENTS, Page 2

MISCELLANEOUS, Page 2

MACHINERY, &c., WANTED, Page 2

SUB-CONTRACTING, Page 2

For Advertisement Rates see First Column Overleaf

CLASSIFIED ADVERTISEMENTS CLOSE FOR

PRESS-NOON WEDNESDAYS

The Engineer

Annual Subscription Rates

(including postal charges)

BRITISH ISLES	£3	5	0
CANADA...	£2	18	6
ABROAD...	£3	3	0

(except Canada)

ADVERTISEMENTS

The Charges for Classified Advertisements are 1/6 per line up to one inch—minimum charge, 9/-; those occupying one inch or more at the rate of 18/- per inch. Box numbers, 1/- extra, except in the case of advertisements under "Situations Wanted." Orders MUST be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
28, Essex Street, Strand, London, W.C.2.
Teleg. Address,
"Engineer Newspaper, Estrand, London."
Tel., Central 6565 (10 lines).

SITUATIONS WANTED

A SCOT WORKS MANAGER, Young, Wide proved progressive experience, all depts., modern plants, SEEKS OPPORTUNITY, STABILITY, and SCOPE.—Address, P6491, The Engineer Office. P6491 B

ACCOUNTANT, 25 Years' Practical Experience, costs and works accounts, DESIRES PERMANENT POST.—Address, P6466, The Engineer Office. P6466 B

CHIEF ENGINEER (41), M.I. Chem. E., public school, holding this and similar responsible executive positions with well-known firms past nine years, WISHES ARRANGE TRANSFER shortly to essential ADMINISTRATIVE POST, preferably in technical control of new enterprise proposing expansion. Exceptional all-round experience 20 years, research, experimental, design, construction and operation heavy and fine chemical, mechanical, and electrical plant, factory lay-out, &c. Expert in technical, commercial, sales development, new plant and processes, good organiser, staff, labour, &c. Present salary £950.—Address, P6486, The Engineer Office. P6486 B

ENGINEER (28), B.Sc. (Eng.), 1st Class Honours, A.M. Inst. C.E., A.M.I.E.E., REQUIRES PROGRESSIVE APPOINTMENT with Telecommunications or Allied Concern. Eight years' administrative and design experience in U.K. and Tropics. Prepared to serve in South Africa or other Dominions.—Address, P6487, The Engineer Office. P6487 B

ENGINEER, Many Years' Experience, Production and design, would like to CONTACT FIRMS interested in Plastic Moulding Machines.—Address, P6500, The Engineer Office. P6500 B

ENGINEER (30) SEEKS CHANGE, London or South preferred. General practical, technical, and chemical experience in light mass production work. Progressive post required, with scope for initiative.—Address, P6499, The Engineer Office. P6499 B

ENGINEER REQUIRES EXECUTIVE POSITION, preferably Works or Assistant Works Manager. Many years' experience machinery, jigs and tools, machine tools, latest methods of production. Free.—Address, P6492, The Engineer Office. P6492 B

ENGINEER (39), A.M.I. Mech. E., A.M.I. Prod. E., A.I. Indust. Admin., DESIRES CHANGE as Production Manager or similar post. Twenty years' experience in mass production, tool design, and control; at present holds executive position; keen, energetic, and tactful disciplinarian.—Address, P6485, The Engineer Office. P6485 B

ENGINEER, A.M.I. Mech. E., M.I.A.E., Having several years' business experience and extensive connections in the Argentine and Uruguay, with transport, utilities, and general engineering concerns, WISHES to CONTACT FIRM of STANDING, view to REPRESENTATION in SOUTH AMERICA on post-war trade development.—Address, P6445, The Engineer Office. P6445 B

ENGINEER, A.M.I.A.E., M.I.P.E., M.I.B.C.M., &c., with high executive ability, WISHES to CONTACT PRINCIPALS with view to POSITION, Chief Engineer and/or Active Director. Successful practical record, large and medium-sized organisation. Age 44. Minimum salary £2000 p.a., plus bonus based on results achieved.—Address, P6496, The Engineer Office. P6496 B

GENERAL WORKS MANAGER, M.I.P.E., A.I.S.E., is open to RECEIVE OFFERS of an EXECUTIVE POSITION; 18 years' experience of general, aircraft, and aero-engine production management, fully qualified time-served engineer, with sound knowledge of factory planning, labour control, rate fixing, processing, jig and tooling, &c. Sound technical and commercial experience, possessing initiative and drive with tact.—Address, P6495, The Engineer Office. P6495 B

SITUATIONS WANTED

ENGINEER, 20 Years' Experience Mass Production Work, REQUIRES SITUATION, Administrative Post. Excellent references.—Address, "2720," Wm. Porteous and Co., Glasgow. P6493 B

FULLY Qualified MECHANICAL ENGINEER, with 10 years' commercial experience as assistant works manager and planning engineer, DESIRES NEW POSITION with post-war prospects, following resignation and release from scheduled undertaking due to unsatisfactory conditions.—Address, P6489, The Engineer Office. P6489 B

IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers 1s. extra, which includes despatch of all replies.

PRACTICAL PRODUCTION EFFICIENCY ENGINEER, administrative, productive organiser, records, planning, progress, time and motion study, machine loading, mechanisation, patents, developments; age 36; salary £1000; willing CONSIDER any WAR or POST-WAR PROJECT.—Address, P6494, The Engineer Office. P6494 B

PRODUCTION and PLANNING ENGINEER EXECUTIVE REQUIRES POST. Wide practical experience works organisation, modern control methods, operation, planning and tooling development problems.—Address, P6498, The Engineer Office. P6498 B

QUALIFIED ELECTRICAL and MECHANICAL ENGINEER, D.F.H., A.M.I.E.E., age 45, with over 20 years' executive experience gained in responsible positions covering the design, lay-out, erection, and maintenance of steam, electrical, and hydraulic industrial power plants, including h.p. and l.p. hot water heating installations,. SEEKS a CHANGE. Salary expected £800.—Address, P6481, The Engineer Office. P6481 B

QUALIFIED ENGINEER (29), B.Sc., A.M.I. E.S., first-class record and references, considerable workshop and design experience on a wide range of mechanical engineering, holding position of responsibility, free now, SEEKS PROGRESSIVE POST with reputable firm. Will consider post overseas.—Address, P6468, The Engineer Office. P6468 B

WORKS ENGR. (40) REQUIRES CHANGE of DISTRICT. Twenty-eight years' mechanical, electrical, marine experience, home and abroad, on all types of plant, mach. shop practice, drawing-office, technical training. Present work light alloy trade.—Address, P6497, The Engineer Office. P6497 B

SUB-CONTRACTING

WANTED

MACHINING WORK REQUIRED, Large or Small Lots, suitable for Centre Lathes (9in, crs. by 8ft.), Slotters, Drills, Shapers, Planers. &c.—STRINGERS, Ltd., Wincobank, Sheffield. 8084 MW

SHEET METAL ACCESSORIES
TO HIGH STANDARDS
For the Aircraft and Electrical Trades. Intricate Metal Pressing and Wire Forms, General Machining, Capstans, Milling, Drilling, Assemblies, &c.

OXY - ACETYLENE WELDING
(LIGHT OR HEAVY).
By A.I.D. Approved Welder. Press Tools, Fixtures, &c. Experimental Work.
FULLY A.I.D. APPROVED.

METAL CRAFTS (LONDON) LTD.
315, High Street, Sutton, Surrey.
'Phone: Vigilant 7642/3.
8514 MW

SHEET METAL WORK,
PLATEWORK,
OXY. CUTTING,
ARC WELDING
and GALVANISING

ARKINSTALL BROS., Ltd., Battery Works, Coventry Street, Birmingham, 5 (telegrams, "Arkinstall, Phone, Birmingham"; telephone, Midland 1666).
A.I.D. Approved.
8524 MW

SPECIALISTS in the REMETALLING and MACHINING of all types of WHITE-METALLED BEARINGS. Prompt service.—A. PASSMORE TYLER, Ltd., 1/7, Barnard Road, Clapham Junction, London, S.W.11 (BATtersea 4347). 8530 MW

MACHINERY, &c., WANTED

WANTED, GEAR BLADE GRINDING MACHINE, to take blades 15ft. long. Licence No. 151. Full particulars.—Address, 8638, The Engineer Office. 8638 F

WANTED, 80/100 Tons DRAWING PRESS, 6in. stroke; SET of BENDING ROLLS, 8ft. long, ¼in./¾in. cap. Full particulars.—Address, 8639, The Engineer Office. 8639 F

WANTED, Geared Undercrank SHEARING MACHINE for cutting 24in. by ¼in. high-speed steel. Full particulars.—Address, 8636, The Engineer Office. 8636 F

WANTED, PLATE BENDING ROLLS, Any size from 5ft. to 9ft. wide, ¼in. plates or thicker, swing end type. Full particulars.—Address, 8637, The Engineer Office. 8637 F

ALFRED HERBERT, Ltd., Coventry, PAY BEST PRICES for SECOND-HAND MACHINE TOOLS in good condition by first-class makers.
Write, wire, or 'phone, and our representative will call. Authorised Dealer's Certificate No. 71. 'Phone: 88781 (20 lines), Coventry; Telegrams: "Lathe, Telox, Coventry." 1002 F

COCHRANE BOILER or Similar Type, around 2000 lb. evaporation.—SUPER SERVICES, 303/7, Holloway Road, N.7. P6456 F

COMPRESSOR WANTED, Suitable Electric motor drive, output 100 c. ft. free air per minute, pressure 120 lb. sq. in., with unloading device, air receiver, preferably two-stage air intercooled.—C.S., Ltd., Staffa Works, Leyton, E.10. 8565 F

EXCAVATION PLANT.—LEADING FIRM of CIVIL ENGINEERING CONTRACTORS are able to USE IMMEDIATELY EXCAVATING PLANT of all types, including Navvies and Tractors and Scrapers, on contracts of first Government priority. Any firm having plant of this order not fully employed is invited to send details, when particulars will be furnished of the terms of hire, which can be varied to cover either long or short periods, and plant can be used in various parts of the country, so that it should be possible in most cases to arrange for it to be within reasonable reach of the owner's premises should he wish to exercise any supervision over same during operation. Drivers need not be found and the whole of the maintenance and replacement of spare parts will be taken care of by the hirers, who will also be entirely responsible for haulage to and from the owner's premises, and will guarantee to return the plant in good order.
Address, 8658, The Engineer Office. 8658 F

We are licensed by the Machine Tool Control for the purchase of all classes of Machine Tools, and we offer good prices for surplus Machinery in any quantities, large or small.
(Machine Tool Control Licence No. 172.)

F. J. EDWARDS, LTD.
359, EUSTON ROAD, LONDON, N.W.1
Telephone No. - EUSton 4681 (10 lines).
Telegrams: "Bescotools, Norwest, London."

REQUIRED TO PURCHASE IMMEDIATELY, SEVERAL STEAM PILING WINCHES, capable of taking 3 tons direct off the barrel, with or without boiler.
GEORGE COHEN, SONS and CO., Ltd., Dismantling Dept., Broadway Chambers, Hammersmith, London, W.6 (Phone, RIVerside 4141). 8613 F

REQUIRED for Urgent Government Contracts, ONE Good Second-hand PLATE EDGE PLANING MACHINE, preferably 10ft. to 15ft., rack or screw driven. Must be in good condition and ready for work.—Address, 8641, The Engineer Office. 8641 F

SECOND-HAND WEED-CUTTING MOTOR LAUNCH REQUIRED by Fen Drainage Board. Howard and Dennis make or similar. Size not exceeding 16ft. by 4ft.—Address, P6443, The Engineer Office. P6443 F

PATENTS

IT is DESIRED to SECURE the Full COMMERCIAL DEVELOPMENT in the United Kingdom of BRITISH PATENT No. 526,514, which relates to "Machine Tools," either by way of the GRANT of LICENCES or otherwise on terms acceptable to the Patentee.—Interested parties desiring copies of the patent specification should apply to STEVENS, LANGNER, PARRY and ROLLINSON, 5 to 9, Quality Court, London, W.C.2. 8634 H

THE PROPRIETOR of the PATENT No. 513,757, for "Improvements in Regenerative Heat Exchanging Apparatus," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine, Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. 8647 H

THE PROPRIETOR of BRITISH PATENT No. 507,733, entitled "Improvements in and relating to Transformer," OFFERS SAME for LICENCE or otherwise to ensure practical working in Great Britain.—Inquiries to SINGER, EHLERT, STERN and CARLBERG, Steger Building, Chicago, 4, Illinois, U.S.A. 8642 H

AGENCIES

MANUFACTURERS DESIRING AGENTS lines of interest to principal operators Passenger Omnibus and Haulage Services ASKED to CONTACT ADVERTISER with connection amongst these users by writing Messrs. W. H. Smith and Son, Ltd., Street, Sheffield, 2. 8691

MISCELLANEOUS

AUTOMATIC MACHINE INVENTIONS QUIRED by Metal Workers for POST MANUFACTURE. All types. Royalty bas inventor.—Address, P6478, The Engineer P6478

CHARTERED MECHANICAL ENGIN with own office, DESIRES to CONT FIRMS of standing with a view to mark their products, present and post-war.—Ad P6476, The Engineer Office. P6476

CLEANING CLOTHS

CLEANING CLOTHS, suitable for mac purposes, are available for Munition a Engineering Works and other Factories n essential work.

Send order on official forms or le heading and forward with remittance 8½d. each.

In lots of 10 dozen or more, 8s. 3d. p dozen.

In lots of 50 dozen or more, 8s. per doz

JOHN HAWKINS and SONS, Ltd., E. Dept., Greenbank Mills, Preston, Lan 8384

DUTTON ONE-WEEK SHORTHAND is La in twelve two-hour postal lessons. 3d. in stamps for first lesson to E. J., 92, Russell Street, London, W.C.1. 9836

ENGINEERS, WORKS and PRODUCT MANAGERS, CHIEF DRAUGHTS BUYERS and STOREKEEPERS will fin profitable to subscribe for "INDUST DIAMOND REVIEW," the new and u technical journal, which does not overla existing publication. It deals with makin using Diamond Cutting, Boring and Alm Tools, Diamond Dies, Jewel Bearings, sives, and Hard Materials. 32 pages, fully trated, published monthly, 12s. a year, Limited subscription list now ope start volume in new form from January Publishers, N.A.G. PRESS, Ltd. (Dept. 226, Latymer Court, Hammersmith, London, 8660

MANUFACTURING and CONSULTING E NEER, with orders to place, DESIRE CONTACT FIRMS having manufacturing c city for immediate and post-war proj machining and fabrication.—Address, P6475, Engineer Office. P6475

POLYGLOT TRANSLATION SERVICE, 237, Terminal House, S.W.1, for TRA LATION IN ALL LANGUAGES, inclu Russian and Polish (Phone, SLOane 7059). 8531

POST-WAR PRODUCTION.—Substantial PANY, with works in London area an Staffordshire, equipped for wide range of duction, skilled engineers, good comm management, OPEN to CONSIDER PROPOS for New Technical Products and Develop Particulars in confidence.—Address, 8611, Engineer Office. 8611

SHEET METAL WORKERS REQUIRE VENTIONS in that line for POST MANUFACTURE. Royalty basis considere Address, P6477, The Engineer Office. P6477

THE ANNUAL STOCKTAKIN

The war has created many difficulties for Engineering and Allied Trades, one being Stocktaking this year with depleted Staff reason of the call of the nation and war d

Many firms are overcoming this difficulty engaging the services of one of the Professi Firms specialising in this class of work

HENRY BUTCHER & CO.
will be pleased to DISCUSS your STO TAKING PROBLEM or the LOSS of ST caused by enemy action.
73, CHANCERY LANE, LONDON, W.C.2
Telephones: HOLborn 8411 (5 lines) EDGware 8121 (3 lines). 8655

TONS of WAXED KRAFT WRAPPI PAPER for second use in bales (da proof).—SLADE, 46B, Great Egerton St Stockport. P6501

FOR HIRE

PUMPS FOR HIRE.
RUSTON DIESEL Centrifugal 8in., 30 Engine, 30ft. lift, 40,000 galls. per hour.
RANSOME and RAPIER, PETROL, fug Centrifugal 3in., 30ft. lift, 10,000 galls. per hour.
SYKES, PETROL, diaphragm 3in., 30ft. 3000 galls. per hour.
HAND DIAPHRAGM, various.
COMMERCIAL STRUCTURES, Ltd., 8 Road, Leyton, E.10 (LEYtonstone 3678). 8567

For continuation of Small Advertisements see page 4

A Seven-Day Journal

The Electricity Supply Industry

A MEMORANDUM prepared by the Incorporated Association of Electric Power Companies, on "The Electricity Supply Industry in Great Britain," has been submitted to the Minister of Fuel and Power. It suggests that revolutionary changes in the constitution and management of electricity distribution, such as are inherent in ownership by a public corporation or Regional Boards, would result in a serious and unnecessary dislocation of the industry, without any compensating benefit to the community. There is no urgency, the memorandum states, for immediate legislation affecting electricity distribution, but as soon as possible after the war the improvement of electricity distribution should be considered on the basis of the Association's proposals and after agreement with the Minister of Fuel and Power and the industry as a whole. It suggests that the improvement of electricity distribution should proceed generally on the lines recommended by the McGowan Committee, subject to the Association's amendments incorporated in the memorandum, in order to facilitate the carrying out of the recommendations of the Committee. The Electricity Commissioners, it is submitted, should delimit suitable electricity districts and appoint a scheme committee for each district to draft an improvement scheme and submit it to the Electricity Commissioners in accordance with the views and recommendations of the McGowan Committee. As far as possible there should be standardisation of the forms of tariffs throughout the country. Complete uniformity of charges is not economically possible, but is feasible in an electricity district. It is further considered that the whole system of valuation and rating should be reviewed in its relation to industry and other public services with a view to legislation in order to remove the existing anomalies and establish a more equitable basis of valuation. Should Parliament decide, however, that retained company undertakings should be liable to purchase by some public authority, then the prescribed period, it is suggested, should be not less than fifty years, and option to purchase should be exercisable at one and the same time for all undertakings. The Association considers that these proposals, if carried into effect, would encourage the progressive and enterprising policy which the industry has always adopted.

The Control of Machine Tools

THE issue of a new Control Order, entitled Measuring Instruments and Machines (No. 1) Order, 1943, is announced by the Minister of Supply, Machine Tool Control, and became operative on and from Wednesday, December 1st, 1943. The Order makes it illegal for any person to acquire any new measuring instrument or machine specified in the Schedule to the Order unless he is the holder of a licence issued by the Minister of Supply. In the absence of a special or general direction, it is illegal for anybody to dispose of new apparatus of the types specified except to the holder of a licence. The measuring instruments and machines concerned are of the more expensive types used in engineering workshops and test rooms for measuring engineering components or for testing the mechanical properties of engineering materials. Persons or firms requiring any of the specified instruments or machines should consult a copy of the Order (obtainable from H.M. Stationery Office) and apply for the necessary licence by forwarding an application form 5 C 1 to the Controller of Jigs, Tools, and Gauges, acting on behalf of the Minister of Supply, at 35, Old Queen Street, London, S.W.1. Copies of the application form, upon the back of which is printed a licence to be completed on behalf of the Minister, can be obtained from the address already mentioned, from the Machine Tool Control Regional Directors at their provincial offices, or from manufacturers of the measuring instruments and machines concerned. Apparatus required for export will also need a licence, obtainable by similar procedure. A licence will remain valid for one month only from the date of issue, and during that period an order must be placed with the supplier named for the apparatus specified. In order to assist procedure and save time in issuing the desired licence, applicants should carefully follow the instructions given in the application form and provide all the information requested. In particular, it should be noted that the application form must be submitted to the Controller of Jigs, Tools, and Gauges in duplicate. The instruments and machines covered by the Order include hardness testing machines, except hand machines, and measuring instruments and machines of the following types, but excluding those acquired by a user at a price below £75:—Alignment and auto-collimating telescopes of the types used in workshops, balancing machines (dynamic and static), bench micrometers, comparators for external and internal measurements, dividing heads and tables of the optical, horizontal and inclinable types, end measuring machines, gear and hob testing machines, optical projection machines, screw pitch measuring machines, surface finish testers, testing machines of the tensile, compression, torsion, fatigue, impact, and spring types, and toolmakers' microscopes.

Surplus Labour in Ordnance Factories

IN the Seventeenth Report of the Select Committee on National Expenditure, which has just been issued, reference is made to the action of the Ministry of Supply in rejecting so emphatically its findings. The Committee, it may be recalled, made certain recommendations in its Eleventh Report, and evidence upon which that report was based showed that by the middle of 1942 there was a large amount of redundant labour and capacity in the Royal Ordnance Factories, especially in the filling factories. The Committee recommended that the possibility of concentrating production in fewer Royal Ordnance Factories and closing the remainder should be examined, and that an immediate joint survey by the Ministry of Supply and the Ministry of Labour and National Service be made. The Ministry of Supply, while admitting the existence of surplus capacity, did not agree that the surplus was excessive and rejected the Committee's findings in regard to surplus labour, but accepted the recommendation that a survey should be made. In its reply to the Committee's request for further information, the Ministry stated that between July, 1942, and June, 1943, the overall labour strength at all filling factories had been reduced by 20 per cent., and estimated that by the end of August that reduction would reach 25 per cent. The production was also concentrated. Four factories had been, or were last July, in process of being closed, and a contractor's factory and an agency factory were to be closed by the autumn of this year. In addition, ten groups of shops within large Royal Ordnance Factories, which it was not considered practicable or desirable to close completely, had been closed. In submitting a second memorandum the Ministry stated that the Committee would realise, no doubt, that the circumstances had greatly changed since its recommendations were made a year ago. The Select Committee does not accept this explanation as adequate, and it suggests that the action taken by the Ministry of Supply indicates that its first reply received insufficient consideration, and the Ministry was, in fact, wrong to reject so emphatically its findings.

British Coal Utilisation Research Association

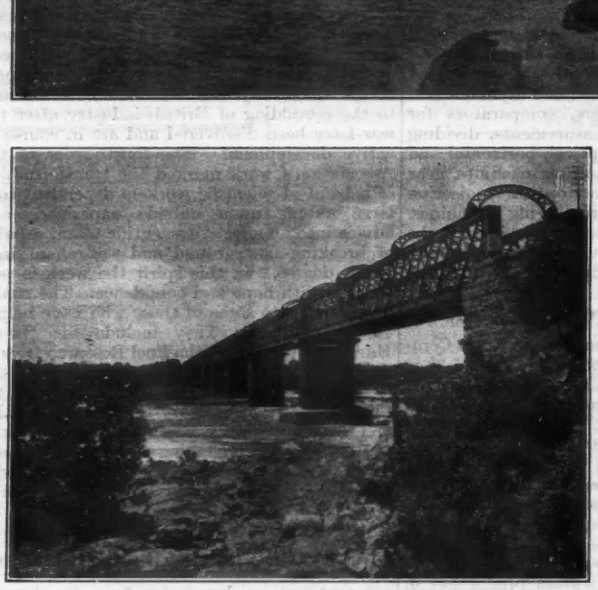
THE British Coal Utilisation Research Association has just issued an illustrated report, entitled "The First Five Years," which, in a convenient and semi-technical form, tells the story of how B.C.U.R.A. came into existence and how it grew up. It is shown that from 1939 to 1941 contant adjustment was necessary in order to meet the new situation caused by the war. By 1941 that readjustment was completed and work was begun on a more balanced programme. In that year the makers of coal-burning appliances and consumers of coal accelerated those sections of the general programme in which they were specially interested. By 1941 combustion was no longer conceived solely in terms of pulverised coal or stoker firing nor the constitution and behaviour of coal and coke in terms of chemical processes alone. New methods of approach were adopted, with fresh conceptions of the process of combustion, the mechanism of heat transfer, the nature of coal itself, and the significance and behaviour of isolated inorganic matter. Many of the principal investigations and developments are described, but others of the utmost importance and promise have of necessity been omitted. It is stated, however, that new processes which may make valuable contributions to the rebuilding of British industry after the war have been discovered and are in course of active development. The fourth year of the Association's work marked the transformation of a band of scientific workers dependent to a large extent upon outside experience and advice into an effective scientific team, capable of breaking new ground and self-reliant in a major degree. In this spirit the work is proceeding with hope and confidence. The report pays tribute to some of those who have helped the Association. They include Sir Harold Hartley, Chairman of the Fuel Research Board; the late Dr. Sinnatt, Director of Fuel Research; the late Lord Rutherford; Lord Riverdale, the Chairman of the Advisory Council of D.S.I.R.; and Sir John Greenly, who contributed so much to the successful launching of the Association in the Department's scheme for Research Associations for assisting industry to marshal scientific resources for its benefit and progress.

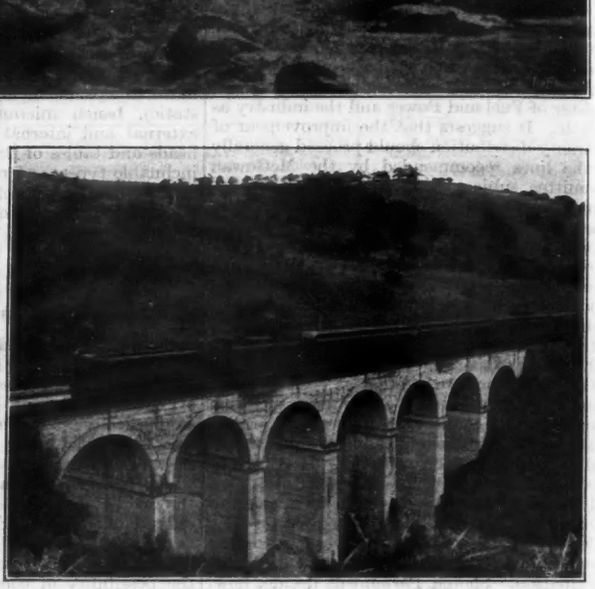
Man Power and the Building Industry

LAST week, a deputation from the London Master Builders' Association, led by Mr. H. C. Harland, the President, was received by Lord Portal, the Minister of Works. In presenting the views of the Association, Mr. Harland said that, while realising that the first consideration was the winning of the war, the Association held that the building industry had now been reduced to the minimum consistent with safety. When the present programme was completed, the Association submitted, it was essential in the interests of the country that the present minimum personnel in the industry should be retained for further possible Government requirements. Should further Government demands not be made upon it, it was equally important that a programme to keep the irreducible minimum employed in the industry should be devised. The Association submitted that as maintenance work was now seriously in arrear, it should be put in hand as part of a definite Government programme, and that licences for this purpose should be given freely, not only to keep the present personnel employed for eventualities and for post-war work, but also to avoid a serious drag on the industry in the post-war period. The Ministry of Labour has already asked the industry to be prepared to augment its present personnel by absorbing men as they are demobilised from the Army and by taking men partly trained and to be trained into the industry. The Association holds the view that it would not be able to do this if the present nucleus of men in the industry is further reduced. When demobilisation takes place it will be quite useless to the industry, the Association states, to have large numbers of men with no special training suddenly thrust upon it. The industry must first of all have returned to it the key men and foremen necessary to mobilise the rank and file coming into the industry, even if that means that the last men in will be the first to be demobilised. In his reply to the deputation, Lord Portal said that he was himself very much concerned with the problems raised, and he was glad to know that the Association had given such serious consideration to them.

BRIDGES IN SOUTH AFRICA

(*For description see opposite page*)





BEIT BRIDGE OVER LIMPOPO RIVER

RAILWAY BRIDGE—FOURTEEN STREAMS

VIADUCT NEAR SHALLCROSS

BRIDGE OVER VAN STAADENS GORGE

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. XXII—(*Continued from page 423, November 26th*)

ROAD TRANSPORT IN SOUTH AFRICA

THE Union has developed a national road scheme, which is estimated to cost £25 to £30 million. Transport is controlled by the State in order to prevent wasteful competition between motor vehicles and the railways along parallel lines. The roads also act as feeders for the railways and provide delightful tours through beautiful country. My own experience of long motor trips inland from Cape Town made me fully appreciate the extensive road construction in the Cape Province. Indeed, Africa, from the Cape northwards, offers great attractions for the motorist.

The National Road Board decides the routes and specifies the details of the construction of the roads, such as class and thickness of foundations, the surface and bitumen to be used, and the radius of curves. Thereafter the work is under the control of the Provincial Administrations. Machinery to the value of £1,739,927 was purchased to secure economy in construction. When the scheme is completed all the big towns in the Union will be linked by a network of fine roads comparable with any in the world.

The standard type of national road costs £1000 per mile and its upkeep £100 per annum. In 1935 it was decided to construct five main national roads, including Cape Town to Durban *viâ* East London, Rand to East London *viâ* Bloemfontein, Cape Town to the Rand *viâ* Kimberley, the Rand to Durban and Pretoria to Messina. The provincial main roads total rather more than 80,000 miles. They remain under existing authorities, with the Government subsidy of one-third the cost of construction and upkeep. There were in 1935 some 2229 bridges under provincial control. Changed economic conditions and the extensive use of road motor transport as a means of developing outlying areas have affected the construction of new railways. The services are mainly operated by six-wheeled pneumatic-tyred vehicles with carrying capacities up to 10 tons. Some 968 vehicles were employed (1939) by the Administration, together with 1500 men.

THE CAPE TO CAIRO ROUTE

It must be remembered that the population served by the railways in Africa is small in relation to area. In an official report (1934) it was stated that there were 13,781 miles of railway in the Union in a region (including South-West Africa and Bechuanaland) of over 1 million square miles, inhabited by 9 million people, of whom about 2 million were European. The natives seldom travel on the railways and it was considered that only 60 per cent. of the Europeans used them. There are long stretches of rail between the chief industrial regions and the ports, and also between the areas which produce raw materials and those where they are consumed. Much undeveloped territory, a great deal of it in arid regions, is traversed by railways. There are very steep gradients from the ports to the interior. During the first 70 miles of the Natal line there are many gradients of 1 in 30, and from Cape Town, Port Elizabeth, and East London there are often gradients of 1 in 40. Cheap coal, however, is a great advantage.

Few engineering projects in the Empire have aroused such interest as the proposal of Rhodes to link the Cape with Cairo by rail. The two cities are 5000 miles apart as the crow flies; if completed, the railway mileage would probably be 7000. Of that length, 2000 miles remain to be completed. It is nowadays considered unlikely that there will ever be rail traffic connecting the Cape with Cairo, as air travel is so much more rapid. However, it first became possible to proceed overland from Cape Town to Cairo in public mechanised conveyances in 1925. In addition to the railways, motor vehicles and steamers on lakes are used. The three great lakes extend about 1000 miles from north to south. The entire trip is made on fixed fares, and the route is within British jurisdiction the whole way. Allowing for delay, the journey takes about thirty-five days. Services are organised, but there are often unexpected difficulties in Central Africa.

SOUTH AFRICAN AIRWAYS LINER AT RAND AIRPORT

The prophetic conception of the all-British "Cape to Cairo Route" of Cecil Rhodes has, however, materialised, even if the mechanical methods used are not altogether those visualised by that great Empire builder. It is no longer an adventure to pass through places where Livingstone, Stanley, and other travellers of less than a century ago went into the dark unknown and were lost for years. In 1934 the International Touring Alliance met in London and voted in favour of a motor road from London to Cape Town *viâ* Khartoum, Juba, and Nairobi, a total length of 10,800 miles. The French delegates preferred a route *viâ* Morocco and the Congo.

BRIDGES AND VIADUCTS

The longest bridge on the railway system of the Union is one crossing the Orange River. It was built in 1915 and is a deck bridge 2974ft. long with 102 spans. It is a low-level bridge and has been submerged by floods for short periods and, although not damaged, floods have caused serious traffic delays. It was therefore decided to build a new high-level bridge of length 3844ft. with twenty-two spans of 100ft. and eighteen spans of 80ft. In most cases it has not been necessary to use spans of great length, the longest in the Union being one of 230ft. in the Gamtoos River bridge.

There are steel viaducts over deep gorges. A steel trestle bridge, 642ft. long and 254ft. high at the centre trestle, spans Van Staadens Gorge. The intermediate spans are 81ft. and the trestle spans 41ft. long. In 1931 a new bridge over the Gouritz River replaced one built by the Cape Public Works Department some years earlier. It is of the trestle type, having four main spans of 150ft., one 50ft. span, and three trestle spans of 40ft. It is designed to carry the heaviest trains likely to be used on the line. The rail level is 210ft. above the river bed and the length of the bridge is 770ft., the cost being £85,000. About 1700 tons of steel work and 24,000 bags of cement were used in its construction.

The Klein Spekbooni viaduct is an example of concrete viaducts, some of which were constructed after 1919, when steel prices rose. There are seven spans of 30ft. on a curve of 462ft. radius, the rail level being 80ft. above the stream bed. In more recent years reinforced concrete has come into use. A bridge of this type over the Buffels River has ten 60ft. elliptical arches. In the early days of railway construction the railways crossed roads at the road level. A great deal of work has been done and a considerable amount of money expended to provide bridges and subways to ensure greater safety, because of the increase in road and rail traffic.

AIRWAYS IN SOUTH AFRICA

Natural conditions in the Union are favourable for civil aviation. The atmospheric conditions may, at times, make high flying necessary, but wind velocities exceed 40 m.p.h. only on an average of about thirty days in the year. The great distances and the open spaces near large towns all aid the development of aviation. In 1938 there were eighty licensed aerodromes and seventy-five emergency landing grounds.

It was in March, 1925, that an experimental air service for ocean mails commenced to operate, but it lasted only a few months. In 1929 Union Airways, a commercial air service, operating under Government contract, began a service. In 1934 South African Airways, a branch of the South African Railways and Harbour Administration, took over all services (except taxi services) in the Union and South-West Africa. In 1937 the service carried 17,240 passengers and flew 653,950 miles. In 1939 regular services, operated by South African Airways, connected centres as far north as Bulawayo and as far west as Windhoek with Cape Town. Government imports of aeroplanes and parts for 1938 cost £394,437.

The Aircraft Operating Company, Ltd., has done a considerable amount of work in the Union, South-West Africa, Southern

Rhodesia, Zanzibar, Tanganyika, Kenya, and Uganda. Although the main purpose was aerial survey, much useful work has been done in connection with forestry, irrigation, soil erosion, mining, and farm prospecting.

EMPIRE AIR MAILS

Milton, the poet, marked out a route for Satan "through the wide Ethiopia to the Cape." Milton's knowledge of the route must have been mostly guesswork, but the idea was sound. The pioneers of the England to South Africa air service must have often wondered if his Satanic Majesty had used his influence to make the route for others impossible. One expert said: "Climatic and atmospheric conditions in Equatorial Africa are most unfavourable for flying; sandstorms or 'haboubs' travelling at a terrific speed more dense than the thickest London fog, and changing the whole face of the ground between Wadi Halfa and Khartoum. South of Khartoum electric storms are particularly violent and the rain, while it lasts, seems like a solid sheet of water. Further south still one meets with waterspouts on Victoria Nyanza, and along the equatorial portion generally terrific 'bumps' are encountered owing to the high hills, extreme heat, and sudden changes of temperature between night and day."

However, early in 1920 four competitors set out from Cairo. Three crashed before leaving the Sudan; the fourth came to grief after 2625 miles. Then, in 1926, Sir Alan Cobham made the journey there and back in the same machine. Many other successful flights were made, breaking time records again and again. In 1936 a prize of £10,000 was won by a flight from Portsmouth to Johannesburg—6154 miles—in 2 days 4 h. 56 min. In that year the flight from Johannesburg to Cape Town was taken over by South African Airways; the Imperial Airways service terminated at Johannesburg. In 1939 the London to Cape record was 39 h. 25 min.; the return journey took eleven minutes longer. The passenger route was opened in 1932. In 1937 the Empire mail scheme carried first-class mail between South and East Africa and the Sudan at 1½d. per half ounce. It was estimated that Empire flying-boats, travelling at night, would finish the England to Cape journey in forty-eight hours. There are air services to other parts of the Empire in Africa that make rapid travel possible from the Cape or other cities in the Union to other commercial centres in the Continent. The enormous development of airfields in Africa for war purposes must result in a great increase in air services in the days of peace.

(To be continued)

SYNTHETIC RUBBER FOR TYRES.—First tests in this country of motor-car, motor-cycle, and small giant tyres made of synthetic rubber from the United States justify the belief that these tyres will give as good service as tyres of "war-grade" natural rubber, according to a review by the Tyre Manufacturers' Conference, representing all British tyre makers. Reports that the American production of synthetic rubber will now meet the United Nations' demands have created a wrong impression, the review states. Synthetic rubber is a new material requiring a new technique, and we have a long way to go to develop a synthetic product which will be sufficiently durable to withstand all the demands made upon it by all types of vehicles. The synthetic rubber, chosen for tyres because it most closely resembles natural rubber and because it can be produced in bulk, develops greater heat than natural rubber, and a proportion of natural rubber, increasing with the tyre size, has therefore to be used with larger sizes of tyres. Conservation of natural rubber, it is pointed out, is accordingly still of paramount importance. Inner tubes made of synthetic rubber are still in the experimental stage, but developments to date indicate that satisfactory tubes may be made.

Salvage of U.S.S. "Lafayette"

No. III—*(Continued from page 420, November 26th)*

UNWATERING PROGRAMME

The unwatering of the "Lafayette" has been done with ninety-three salvage pumps mounted within her on hinged platforms that have had their opposite ends pendant from blocks and falls that permitted the platforms to be maintained level at all times during the righting of the ship—Fig. 8. This was done to ensure the efficient operation of the pumps, all of which have been driven by petrol engines. For the great unwatering task there were used twenty-five 3in. centrifugal salvage pumps, twenty-eight 6in. centrifugal salvage pumps, and forty 10in. centrifugal salvage pumps. The total capacity of all pumps is stated to have been 40,000 tons per hour. By the method of controlled pumping, and the arrangements made for that purpose, it was entirely practicable to use as much or as little of the pumping capacity as was found to be needed at the different stages of righting and refloating. An average of 700 men worked daily on the wreck, and of that force an average of seventy divers was engaged daily during the operations.

The programme for bringing the "Lafayette" up from the bottom, when finally made ready for unwatering, called first for rotating the ship slowly, possibly over a period of some days, from her inclination of slightly more than 79 deg. from the vertical to an approximate inclination of about 45 deg., this initial stage of rolling to be effected while the craft remained resting with her port bilge on the bottom of the slip—see diagrams, Fig. 9. With that accomplished, the schedule called for a change in the operations by which the "Lafayette" would be given sufficient additional buoyancy to cause her to rise free of the water bed, but still retaining her heel of 45 deg. The intention also was, as soon as the vessel

FIG. 7—PUMPING OUT AT NIGHT

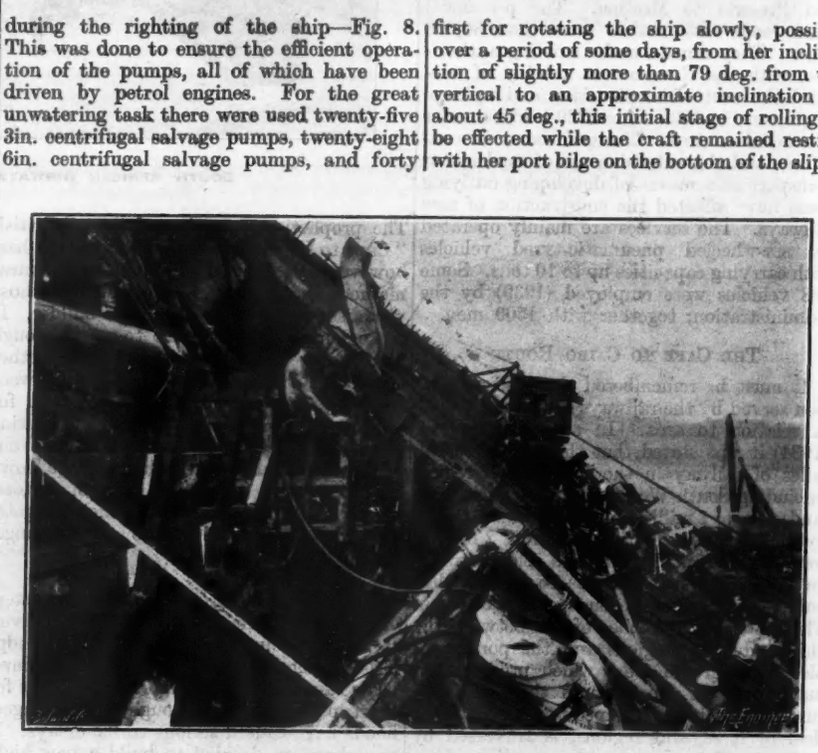


FIG. 8—LIST REDUCED TO 45 DEG.

floated, to pull her stern out from its proximity to the outer end of pier 88 and to hold her, with beach gear secured to her bow and stern, substantially parallel and close to the centre line of the slip, so that any possible abrupt final righting movement would take place safely away from either of the flanking piers. Actually, some of these precautions were not needed, at least to the extent expected, because the rolling during righting and refloating was at all times under perfect control, and the angular movement was astonishingly smooth and slow. To minimise suddenness in the ship's initial rolling, air and water jets were used to break the seal between the mud of the water bed and the contact surface of the hull. Apparently, the "suction" between the ship and the mud was disposed of, as evidenced by the way the craft started to right herself. As was to be expected, the hull plating of the "Lafayette" was sufficiently deformed and ruptured to cause leakage when the ship had rested for about a year and a half on the edge of the rock shelf beneath the craft's forebody. This was discovered during pumping of the compartment contiguous to that section of the shell. The fracture was sealed by divers in advance of the concluding salvage operations.

At all stages during the pumping operations, which entailed the removal of 100,000 tons of water, the pumps were kept at elevations above the surface of the dropping water that would ensure their effective operation, and the pumps were therefore lowered and their platforms re-established successively at lower positions within the vessel. In each case the platform was secured just above the surface of the water, and the interval between the platform and the water at no time exceeded 25ft. The righting of the "Lafayette" was begun on August 2nd, when the preliminary pumping operations started, which was essentially a general testing of the pumps and the provisions for their control, and also to gauge the existence of leaks and the probable volume of water moving through them. Four days later the ship slowly began righting herself, and by the morning of August 8th she reduced her list by 8 deg., and was definitely "on the way up." By August 9th she had reduced her heel to 47·80 deg., and between 10.30 a.m. and 10 p.m. she lessened that inclination to 45 deg.—Figs. 7 and 8. By that time the ship just cleared the bottom of the slip at high tide, the tidal range being about 4·5ft., and settled back in the mud at low tide. By August 16th the ship had been brought up—that is, righted—so that she had a heel of only 32·9 deg., and then pumping was halted, as explained by Lieut.-Commander C. F. Chandler, U.S.N.R., Resident Salvage Officer at pier 88, who said that the pause was to close small leaks that had been found and to shift the pumps to new positions. Subsequently, when the list was but 30 deg., pumping again was stopped and some time devoted to removing parts of the timber and concrete bulkheads to reduce that unbalancing load and to lighten her, so as to enable the vessel to assume a more nearly normal position when compensating water was placed in the starboard fuel tanks, which had remained loaded with oil following her sinking, and were not pumped until just before the ship's unwatering was started. Except for small leaks that were easily kept under control by the lesser of the centrifugal pumps placed where they could draw from sumps provided for the purpose, the last of the 100,000 tons of water that had flooded the "Lafayette" while she was lying on the bottom of the slip was removed by the end of the week of August 16th, and the vessel was afloat. During the following week work was under way in removing the temporary timber and concrete bulkheads and in taking the steps needful to restore the craft to an even keel. That disposal of those extensive temporary structures was expected to require several weeks. The ship would then be ready to be towed to any dockyard where her renovation and conversion for wartime use, if so considered desirable, would be undertaken. That task will undoubtedly be a protracted one.

Stripping steelwork from the sunken vessel, both above and below water, during the various steps in making ready for her salvage has strikingly stressed the value of present-day metal-cutting torches for doing such work. Above water the cutting was largely done with oxy-acetylene torches, and below water oxy-hydrogen and oxy-electric torches were utilised, and where each type of apparatus would best serve the purpose. Mr. M. C. Gilbert, a construction engineer of notable ability and a member of the Merritt-Chapman and Scott Corporation, who has been second in charge of the salvage operations, is well known for his studies in underwater cutting and welding; but it does not seem that underwater welding was resorted to in dealing with any problem connected with the reclamation of the "Lafayette."

The estimated total cost of righting and refloating the "Lafayette" was 3,750,000 dollars, and expenditures for that purpose up to June 1st of the current year amounted to 3,050,000 dollars. Testimony given before a Congressional Committee placed the ultimate outside cost of raising and rehabilitating the ex-liner and fitting her for a great troopship at 20,000,000 dollars, a relatively low price to pay considering what the craft originally cost.

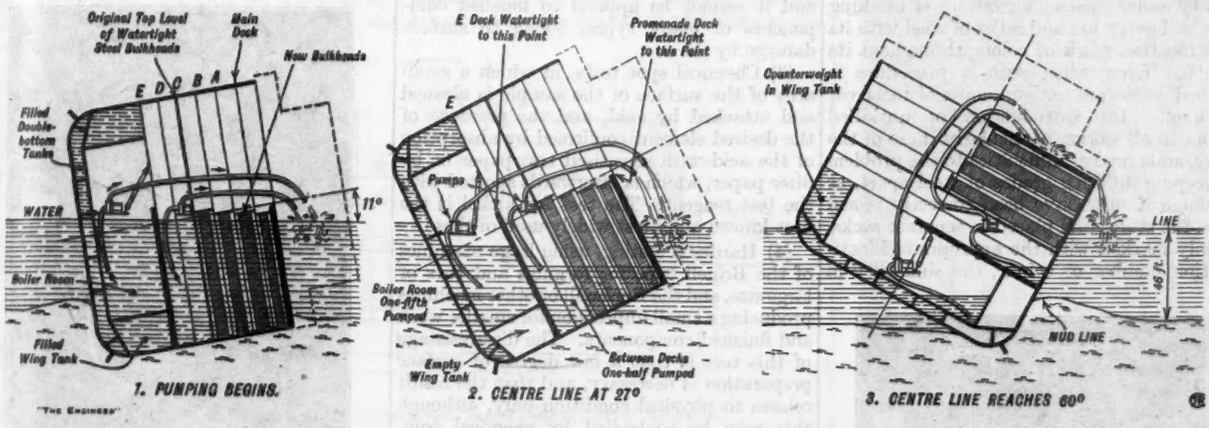


FIG. 9—DIAGRAM ILLUSTRATING UNWATERING OF SHIP

FIG. 10—TOWING SALVAGED U.S.S. "LAFAYETTE" TO DOCKYARD

A New Method of Sorting Steels

By R. J. BROWN and J. BRIDLE

ONE of the most annoying occurrences in any engineering works, particularly those engaged on quantity production, is the mixing of different grades of steel. This may occur in the steel works or in the users' works, but in both cases it is due to the practical impossibility under existing conditions of marking each and every bar and billet of steel with its identification mark or colour throughout its length. Even when such a procedure is applied, cases are not unknown of incorrect marking. The introduction of unskilled labour in all works, particularly those of the users, adds further difficulties to the problem of keeping differing grades of steel apart, as although it may have been correctly issued from the stores and placed in separate racks, plainly marked with the appropriate identification number or colour, the similarity in

Normalised sample as standard
a, Normalised specimen
b, Oil-quenched specimen
c, Oil-quenched and fully tempered specimen

FIG. 1—OSCILLOGRAPH CURVES FOR 40 CARBON STEEL.

appearance of bright or black bars of the same size, but differing qualities, confuses these operatives, who rarely understand that steel is supplied in a multitude of grades.

There are four general methods in use for the sorting of mixed steel, three of which depend upon differences in chemical composition and one on differences in physical condition. They are :—

(1) Spark testing, using an abrasive wheel against which the sample to be tested is held. The stream of sparks evolved gives characteristic indications of the main chemical elements present, and this method is widely used at the present time, although its application is limited to bar and unfinished components, owing to damage to the surface of the sample by the wheel.

(2) Spectroscopic testing, using the Hilger Spekker steeloscope, in which an arc is struck between the sample and a standard electrode, and the appropriate portion of the spectrum viewed in the eyepiece of the instrument. The presence and intensity of the appropriate line or lines gives an indication of the amount of the element present, but considerable experience is necessary when using such apparatus. Unfortunately, variation in carbon content cannot be detected by this method, and it cannot be applied to finished components of many types, owing to surface damage by the arc.

(3) Chemical spot tests, in which a small area of the surface of the sample is cleaned and attacked by acid, and the presence of the desired element confirmed by absorption of the acid with sensitised test paper or by filter paper, which is afterwards spotted with the test reagent. The test for nickel is the best known and most widely used of these.

(4) Hardness testing, using large machines of the Brinell type for forgings and bars of large size, and the Rockwell or other machines producing a small impression for smaller work and finished components. The disadvantage of this test is that a fair degree of surface preparation is necessary, and that the result relates to physical condition only, although this may be controlled by chemical composition.

With the exception of spark testing, all these methods involve an appreciable amount of extra work, and this one in particular requires a high degree of practical experience and generally necessitates the material being taken from one location in the works to another for test.

Over a considerable number of years, numerous workers all over the world have endeavoured to establish a definite relationship between the magnetic properties of ferrous materials and their chemical composition and physical condition. The establishment of a definite and characteristic relationship of this kind could obviously be made the basis of a method of sorting mixed materials or measuring at least some of their properties. The use of search coils with sensitive galvanometers has proved to be unreliable, owing to the extremely slight differences in the magnetic properties of the various engineering steels, and the employment of a cathode ray oscillograph for the sorting of mixed steel castings appeared to hold considerable promise.[1, 2, 3] This apparatus embodies an amplification system making it extremely sensitive to magnetic differences in the samples, but it is not sufficiently robust to be considered a workshop instrument, and a simplified form of apparatus embodying an amplifier, but replacing the oscillograph unit with a cathode ray tuning indicator, has been developed.

Electro-magnetic devices of the type under consideration for the detection of differences in steel are based upon variations in magnetic flux between a standard and the samples to be tested. Magnetic properties of steel are dependent upon chemical composition and physical condition. Increase in carbon content produces an increase in coercivity, resistivity, and retentivity, with a reduction in permeability and saturation point. Increase in carbon content also has the effect of broadening the hysteresis loop and increasing its area, and this effect is more pronounced

Normalised 40 carbon standard (En. 8)
a, Normalised manganese-molybdenum steel (En. 16)
b, Hardened and tempered manganese-molybdenum steel (En. 16T)

FIG. 2—OSCILLOGRAPH CURVES FOR STEELS OF DIFFERING COMPOSITION

in hardened steel than in soft or annealed material.[4] Alloy additions and impurities also affect the magnetic properties of steel, and it appears at first that the number of factors influencing magnetic variations would defeat this method of sorting unless the chemical composition of the samples being tested is similar, their physical condition only being varied, or their physical condition similar and their composition variable. It has been found, however, that the apparatus developed is capable of sorting mixed material in which there may be variations in both chemical composition and physical condition. In such cases it is usual to separate the material into groups according to composition and then re-test each group against a satisfactory sample of that group.

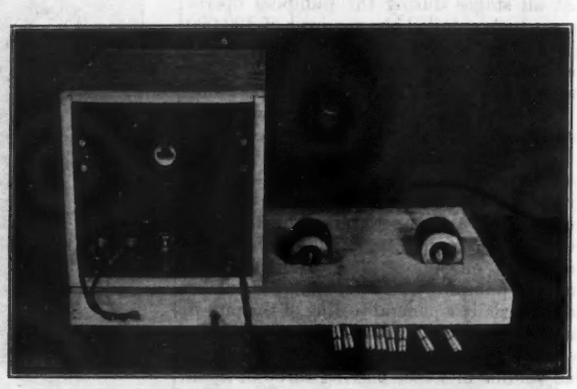


FIG. 3—ORIGINAL APPARATUS

In this apparatus the magnetic differences between a standard specimen and the sample,

[1] "Rapid Sorting of Small Mixed Castings," by C. S. Williams, *Metal Progress*, June, 1942.

[2] "Fast Sorting of Mixed Pieces by their Magnetic Characteristics," by R. E. Cavanagh, *Metal Progress*, September, 1942.

[3] "Magnetic Inspection Achievements to Date," by Lewis S. Reid, *Metal Progress*, June, 1931.

[4] "Standard Handbook for Electrical Engineers," edited by A. E. Knowlton (McGraw-Hill).

which must be of the same cross section, are measured under the influence of equal alternating magnetic fields. The equipment comprises a pair of air-cored transformers and the necessary indicating device. The transformers must be of sufficient diameter to accommodate the sample under test, the primary windings having insufficient magnetising force to saturate the steel. The secondary voltage which is induced in each transformer is dependent upon the magnetic flux caused by the insertion of the samples in the transformers. The primary windings are connected in series to the A.C. mains; the secondary windings are also connected in series, but in opposition to one another, so that the resultant secondary current is nil when their mutual inductances are equal. In order to achieve this condition, both primary and secondary windings must be identical.

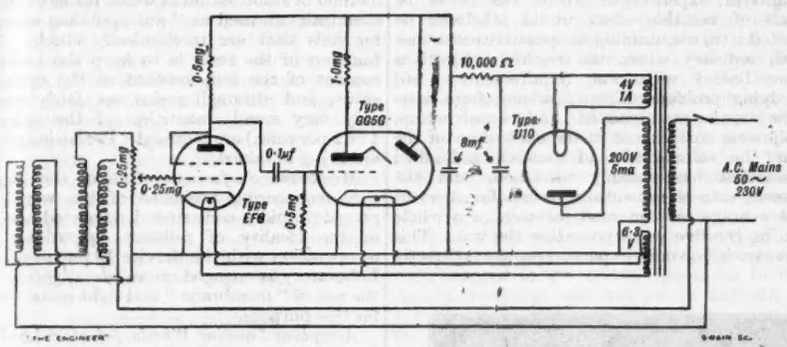


FIG. 4—WIRING DIAGRAM OF APPARATUS WITH SENSITIVITY CONTROL

When a sample of steel is inserted, so becoming the core of either transformer, a current is induced in the secondary circuit of the apparatus. On progressively inserting a further sample in the second transformer, the resultant combined secondary current is reduced until a critical point is reached at which it is a minimum. If the samples in both transformers are identical in chemical composition and physical condition, the combined secondary current will be nil, owing to the output of both secondary windings being equal, thus cancelling one another out, owing to their connection being in opposition. A remaining current is always found to exist if there is the slightest variation in the two samples, due to difference in the hysteresis loops of the specimens. Typical oscillograph curves for normalised, hardened and tempered, and hardened steel to B.S. 970 En. 8/12, are shown in Fig. 1, using a normalised sample as the standard. The curves for normalised and heat-treated alloy steel, En. 16, against normalised En. 8 as a standard, are shown in Fig. 2. These curves illustrate clearly the marked differences in the magnetic properties of steel having varying chemical composition or physical condition, the remaining current referred to being proportional to the vertical height of the loops. It is on this remaining current that the present method of sorting depends, detection being made possible by the indicating device, consisting of an amplifier feeding a cathode ray indicator, whose sensitivity is under control for the purpose of adjusting to the greatest deflection on samples having the maximum permissible variation from the standard, if the material is to be sorted according to slightly differing physical characteristics. This sensitivity control is not required when material of mixed composition is to be sorted, as the magnetic differences will be sufficiently great to give either a complete absence of current in the secondary circuit for material equivalent to the standard sample or a very considerable current if the materials are different.

The apparatus in its original form is shown in Fig. 3, and was not provided with the sensitivity control, being used solely for the rapid sorting of several thousands of studs made from high-tensile steel with which a small proportion of mild steel had become mixed during manufacture. A stud in the correct grade of steel was used as a standard in the first transformer, and when a stud of similar material was inserted in the second transformer a complete balance occurred between the two secondary windings, shown by a sharply defined sector on the cathode ray indicator; when a mild steel stud was inserted the lack of balance, or resultant voltage, was indicated by a negative or ill-defined sector. In this form of apparatus the angle of the sector was found to vary appreciably with studs known to be of similar composition. Examination established that this was related to variation in microstructure and hardness.

The wiring diagram of the apparatus embodying the sensitivity control is shown in Fig. 4, and many thousands of small components produced from bar stock have been sorted by means of this apparatus. By mounting the transformers separately the test becomes applicable to bar material in the steel mill, bar stores, or machine shop, Fig. 5 showing its use in this capacity.

FIG. 5—SORTING BAR STOCKS

This method of sorting is extremely rapid, occupying only a fraction of the time required for hardness testing, even when the most rapid of the accepted methods are used. A considerable proportion of the components rejected when the apparatus was first used were checked by chemical analysis, and in every instance their incorrect composition was confirmed. Similar precautions were adopted when sorting heat-treated from as-rolled material of the same composition excepting that confirmatory tests were made for hardness and micro-structure. When used for sorting heat-treated material according to micro-structure, check testing showed at least 90 per cent. success, the remaining 10 per cent. being on the minimum of the specified hardness range.

Details of some of the materials which have been satisfactorily sorted are given in Tables I, II, and III. The first refers to studs approximately 4in. in length, ordered in steel equivalent to B.S. 970, En. 12, but which were found on delivery to be exceptionally soft when a proportion were subjected to routine acceptance tests. The whole consignment, comprising several thousand components, was sorted into two groups in a matter of a few hours, using a stud of normal composition in the specified hardened and tempered condition as a standard. The rejected soft studs had been made in error in a rimming steel.

Mention has previously been made of the magnetic balance occurring when similar samples are inserted in both transformers, being indicated by a positive sector on the cathode ray indicator. This is illustrated

TABLE I

Test indication.	Micro-structure.	Hardness VPN/50	Carbon, per cent.
Magnetic balance	Sorbite	165	0·32
Completely out of balance	Ferrite and sorbite	95	0·08

TABLE II

Test indication.	Micro-structure.	Hardness VPN/50	Chemical composition.			
			C.	Mn.	Ni.	Mo.
			Per cent.	Per cent.		Per cent.
Magnetic balance	Sorbite	300	0·30	1·34	Nil	0·31
Completely out of balance	Ferrite and sorbite	170	0·22	0·72	Nil	Nil

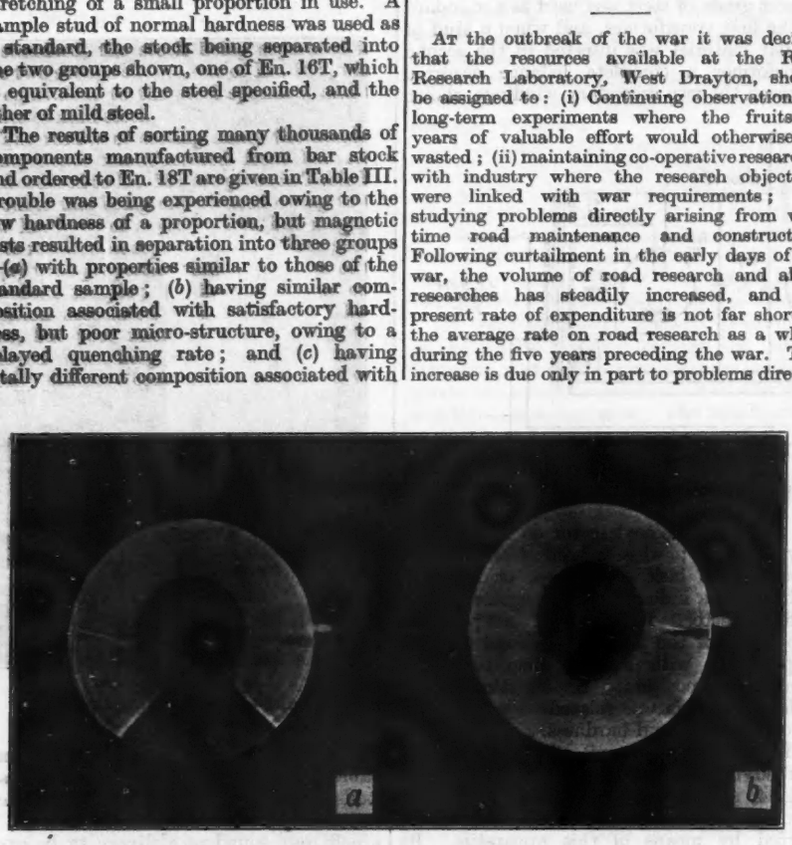
TABLE III

Test indication.	Group.	Micro-structure.	Hardness VPN/50	Chemical analysis.				
				C.	Mn.	Ni.	Cr.	Mo.
				Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Complete balance	*a*	Homogeneous	291	0·38	0·73	0·39	1·16	Trace
Partial balance	*b*	Heterogeneous	261	0·41	0·84	0·31	1·16	Trace
Complete lack of balance	*c*	Banded loose sorbite	240	0·32	1·03	0·31	0·24	0·40

in Fig. 6*a*, whereas Fig. 6*b* shows the indication obtained when the samples in the transformers are of different materials producing a remaining current in the secondary circuit of the apparatus.

In Table II is given a summary of confirmatory tests made on another small stud manufactured from bar steel ordered to B.S. 5005/302. Sorting was necessitated by stretching of a small proportion in use. A sample stud of normal hardness was used as a standard, the stock being separated into the two groups shown, one of En. 16T, which is equivalent to the steel specified, and the other of mild steel.

The results of sorting many thousands of components manufactured from bar stock and ordered to En. 18T are given in Table III. Trouble was being experienced owing to the low hardness of a proportion, but magnetic tests resulted in separation into three groups —(*a*) with properties similar to those of the standard sample; (*b*) having similar composition associated with satisfactory hardness, but poor micro-structure, owing to a delayed quenching rate; and (*c*) having totally different composition associated with low hardness and unsatisfactory micro-structure. The first two groups were acceptable, having regard to their satisfactory mechanical properties, whereas the third group was rejected, their rejection being subsequently confirmed as a reasonable procedure by resorting against a standard sample of similar composition (En. 17T), which had been properly heat treated to the desired mechanical properties.



a, Complete balance between the secondary windings *b*, Lack of balance between the secondary windings

FIG. 6—INDICATIONS OF BALANCE AND LACK OF BALANCE

Many further examples of materials which have been sorted on this apparatus could be quoted, but those given illustrate quite clearly the clarity with which mixed steels can be classified according to chemical composition or physical condition. It should be understood that slight differences in chemical composition are of little account, and that this may vary over the specified range for the particular steel being sorted without any marked difference being observed in the magnetic balance obtained, providing the physical condition is similar. The difference in the indications when there is great difference in the chemical composition as in varying grades of steel, is, however, so apparent that the most unskilled operative can be given the task of sorting the mixed material.

This method of sorting is not claimed to be original, although the method of indicating the difference is new, but the purpose of this article is to place before the engineering trades a rapid method of sorting mixed steels by an apparatus which is portable, inexpensive, and easily constructed, at a time when there is great need for such an apparatus.

The authors are indebted to the directors of Morris Motors, Ltd., for permission to publish this article.

Road Research in Wartime

AT the outbreak of the war it was decided that the resources available at the Road Research Laboratory, West Drayton, should be assigned to: (i) Continuing observations of long-term experiments where the fruits of years of valuable effort would otherwise be wasted; (ii) maintaining co-operative researches with industry where the research objectives were linked with war requirements; (iii) studying problems directly arising from wartime road maintenance and construction. Following curtailment in the early days of the war, the volume of road research and allied researches has steadily increased, and the present rate of expenditure is not far short of the average rate on road research as a whole during the five years preceding the war. This increase is due only in part to problems directly concerned with the maintenance of public highways. It is due to a considerable extent to three other factors: First, to the large constructional programme of roads to factories, camps, and other war establishments in connection with which special information or advice has been called for; secondly, to the urgent problems connected with rapid road construction for military purposes; thirdly, to the creation of an entirely new field of research in the construction and maintenance of runways for aerodromes. Problems of runway construction, all of which are allied to road problems, occupy in fact a large and increasing place in the Laboratory's activities.

From a report summarising the Laboratory's wartime activities we take the following notes.

Soil Identification.—The growing use of soil as a constructional material for war purposes led to the need for a far more precise description of British soils than is given by such terms as "plastic clay," "sandy gravel," and so on. The Laboratory has adopted, and adapted, the American technique of classification in which soils are identified by the grain size distribution (mechanical analyses) and by their plastic and liquid limits. Many British soils have been examined in this way and the information has been used to advise the Service Departments and others on the best methods to adopt in constructional works.

Soil Stabilisation.—Very big strides have been made during the war in applying soil stabilisation to road and airfield construction, and a number of roads and runways in different parts of the country have been constructed in this way. The Laboratory has been concerned in most of these developments, many of which have required not only preliminary laboratory work, but full-scale trials in the field and control over the technical details during the progress of construction. The work has been carried out in co-operation with the Service Departments and the Ministry of War Transport, and liaison has also been established with the work of the U.S. Corps of Engineers in this country. Nearly all methods of soil stabilisation have been tried —mechanically stable mixtures, soil-cement and bituminous stabilisation. Bituminous sand-mix construction in particular has been widely used on airfield work in this country, and the Laboratory has assisted with development and control work on a large number of airfields. Development work is also in hand on a new method of stabilisation in which resins or specia chemicals are used as "waterproofing agents" for soils that are mechanically stable. The function of the resin is to keep the moisture content of the soil constant at the optimum value, and although resins are fairly costly, only very small quantities (of the order of 1 or 2 per cent.) are required. Promising results are being obtained.

Membrane Surfacings.—One of the biggest civil engineering problems of the war is to provide rapidly constructed advanced airfields in the locality of military operations. In co-operation with the Service Departments the Laboratory is engaged on an investigation into the use of "membrane" and light metal tracks for this purpose.

Aeroplane Landing Wheels.—A start has been made on the problem of measuring the deflection of flexible type runways under aircraft landing wheels. The increasing weight of aircraft has brought into prominence, in relation to post-war as well as to present requirements, the question of designing bases and concrete runways to resist very heavy loads. This problem is also fundamental in road design.

Frost Damage to Concrete.—Although the pre-war researches on concrete roads have had to be suspended, several problems directly arising from the war have been given attention. One of these has been the frost damage suffered by the concrete surfaces in many parts of the country, due partly to an unavoidable lowering of standards of construction and partly to the severity of recent winters. The frost resistance of concrete has been found to be particularly affected by the water content of the concrete at the time of mixing.

Wear of Roads by Tanks.—The use of roads by tanks has in many places caused considerable damage. The wear occurs mostly on corners and is due to the rubbing and turning action of the track links on the road surface. In co-operation with Army engineers and the Ministry of War Transport tests are being made to determine the best method of concrete road construction to resist wear, and trial lengths are being subjected to the severest conditions obtainable.

Colnbrook By-pass Experiments.—Work on bituminous materials has been mainly concerned with wartime road maintenance, with the design of runway surfacings, and with special problems connected with military operations. In all this work invaluable data have been provided by the extensive programmes of road trials initiated on the Colnbrook By-Pass, with the co-operation of the Ministry of Transport in the years preceding the war. This has been particularly so in the case of the 1939 series of carpets (surfacings ½in. thick) which originally contained over 700 separate sections. Economies necessitated by the war have led to a widely increased use of these thin surfacings, and the results of the experiment have clearly shown the correct basis of design. A parallel series of trials sections was laid in Lanarkshire with the co-operation of the Ministry of War Transport and the County Surveyor in 1942 to see whether the conclusions drawn from experiments in the South of England can be applied without modification under the different climatic conditions of the North.

Wet Aggregates.—It has been known for some years that the affinity of stone for bituminous binders can be increased by the addition of "wetting agents." Great savings of time and labour would result if the principle could be applied to the use of aggregates in a wet,

unheated condition for manufacturing bituminous mixes. The Laboratory has been investigating this possibility, particularly with reference to wartime road construction, and the conditions under which undried stone can be used successfully are now fairly well established.

Tyre Wear.—In view of the rubber shortage, investigations into the relation between road surface and tyre wear have been put in hand. So far it has been found that the heaviest wear is caused by surface dressings, particularly when applied to concrete, and that bituminous surfaces give the least wear. Experiments are now in progress to determine whether the size of stone used in surface dressings has any relation to tyre wear, and also what is the effect of different types of stone.

Solid and Steel Tyres.—Experiments have been made with vehicles fitted with resilient wheels having tyres of steel or other hard materials. The effect of such tyres on road surfaces is being observed in order to provide information regarding the relative durability of present roads to traffic of this nature.

Camouflage.—In connection with the camouflage of roads and aerodromes, measurements have been made of the light-reflecting properties of a large number of surfaces of all types. Methods of camouflaging concrete have been investigated and recommendations have been issued to the authorities concerned.

Flexible 65-Ton Pneumatic Press

IN our issue of June 5th, 1942, we published a description of a pneumatic press designed and made by Charles D. Holmes and Co., Ltd., to work in conjunction with the "Blackburn" method of precision pipe bending (see THE ENGINEER, April 3rd, 1942). That firm now informs us that a large number of such presses has been supplied to the Ministry of Aircraft Production, and that as a consequence the query has often been asked whether the presses would bend satisfactorily mild steel marine pipes of large diameter. To satisfy a demand that was thus obviously in existence for a more powerful press, the firm has now placed on the market the 65-ton pneumatic press illustrated by the accompanying drawing.

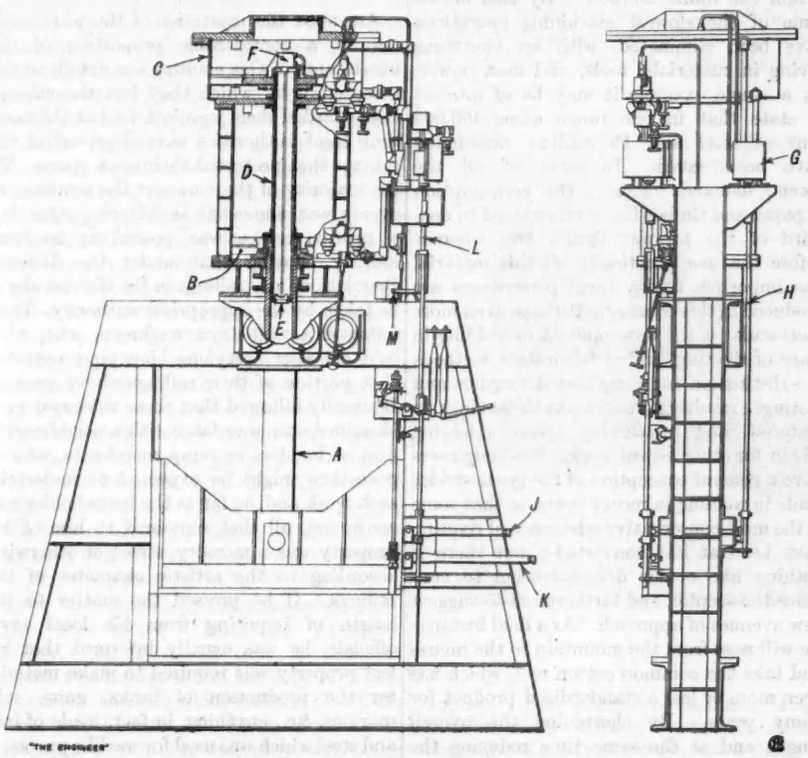
As the basic design of this new tool is closely similar to that of the press we have already described, we intend to refer only to those features which are novel. The firm set out with the object of producing a press that could, besides exerting heavy pressures where desired, be economically used for lighter pressure work. To achieve this flexibility the press has been so designed that two separate cylinders are used, one exerting pressures up to 20 tons, the other an additional pressure of 45 tons. The two cylinders are ingeniously linked by a form of telescopic piston-rod. The piston-rod A of the ram is directly connected to the 20-ton piston B. The place of the cover of the 20-ton cylinder is taken by a second cylinder C, within which works the 45-ton piston. The hollow rod D of this piston is capable of sliding within the hollow bore of the 20-ton piston-rod. At the bottom of the 45-ton piston-rod there is a non-return valve E linked by a rod to an auxiliary air cylinder F, by which it can be opened or closed. Oil or water partially fills the spaces within the hollow piston-rods, and hydraulic leathers seal it within them. Thus it will be seen that when the non-return valve E is open relative movement between the piston-rods can taken place, but that when that valve is closed any pressure exerted on the top of the 45-ton piston will be transmitted through the fluid trapped in the 20-ton piston-rod to the ram of the press, and will act in addition to any pressure exerted on the ram directly by the 20-ton piston. Suitable metal stops are fitted so that the pistons can be brought to rest without danger of damaging the sealing rings.

The two pistons are operated by separate slide valves and separate control handles J and K for the 45-ton and 20-ton cylinders respectively. The 45-ton control valve G has a second set of ports connecting with the auxiliary cylinder F for the automatic operation of the non-return valve E. Though separate control handles are fitted, they are so linked together through rod L that opposing operations cannot be engaged. Moreover, when the press is at rest and the air supply is cut off, a balance-weight M, by ensuring that the slide control valves are at the tops of their strokes, causes both pistons to move upwards as soon as air is admitted, an arrangement that obviates any possibility of damage or danger should air be accidentally or unexpectedly admitted.

To operate the tool, the 20-ton control handle K is first depressed, thus admitting air to the top of the lower cylinder and causing the ram to descend. Meanwhile, the other control handle J remains where it is, holding the upper piston at the top of its stroke, and maintaining the non-return valve E open. If the full 20-ton pressure is not sufficient to perform the work under the press, control handle J is depressed. Air is first admitted to the auxiliary cylinder F, causing the non-return valve to close, and then to the top of the 45-ton piston, forcing it downwards, and adding to the pressure on the ram. On the completion of the work an upward movement of handle K, owing to the arrangement of the interlinkage, causes handle J to rise also, with the result that both cylinders are reversed. Alternatively, handle J alone can be raised, when the non-return valve will be opened and the 45-ton piston alone lifted.

From the above description it should be clear that this press can be used economically for work only requiring pressures up to 20 tons without that wastage of air that would be involved had it only a single cylinder with a diameter sufficient for the exertion of 65 tons pressure. It may further be observed that even when exerting pressures in excess of 20 tons the additional air required is only that necessary to fill the clearance spaces of the upper cylinder, together with the amount used during the stroke at pressures exceeding 20 tons. The press should therefore be economical of air on heavy work as well as light.

The air pressure for which this tool is designed is 100 lb. per square inch, the pressure usually standardised in engineering works. The floor space occupied is 11ft. by 2ft. The firm informs us that the first of these new presses is already in operation, and has bent pipes up to 6in. in diameter with ease. It has, too, been used for other purposes, such as straightening bent bronze propeller blades and for pressings in steel.



ARRANGEMENT OF 65-TON PRESS

Sixty Years Ago

WESTINGHOUSE *v.* THE L. AND Y. RAILWAY COMPANY

ON December 3rd, 1883, before Mr. Justice Denman, in the Queen's Bench Division of the High Court of Justice, Mr. George Westinghouse brought an action against the Lancashire and Yorkshire Railway Company on the ground that an automatic vacuum brake which the company was using infringed his patents. Infringement was claimed in two respects, one being in connection with the design of the valve through which the reservoir under each carriage was charged, and the other being as regarded the arrangement of the rigging by means of which the brake blocks were applied to the wheels. The defendants pleaded that there was no infringement and that the plaintiff's patents were void by anticipation. The Westinghouse patents involved in the case were those of 1873 and 1874. The importance of the action lay in the fact that, under the existing law, if any one claim in a patent was proved to be invalid all the other claims fell to the ground with it. Very naturally the case excited great interest in engineering and particularly railway circles. Many expert witnesses were called on each side. During the eighth day of the hearing the jury became restless. They complained to the judge that they were being called upon to listen to witness after witness simply repeating the testimony of those who had preceded them, and besought him to take steps to shorten the action. The judge was sympathetic, but refused to intervene on the ground that the effect of any attempt by a judge or jury to shorten an action was generally the institution of another action at a later date. Among those who gave evidence during the course of the action were Mr. Imray and his partner Mr. Abel, Dr. John Hopkinson, Mr. Dean, of the Great Western Railway, Mr. Aspinall, of the G.S. and W. Railway of Ireland, Mr. Fisher, of the Taff Vale Railway, and Mr. Shotton, of the Great Northern. On the tenth day the action came to an end. The jury found that there had been no infringement of Westinghouse's patents as regarded the valve, but that there had been infringement as regarded the brake rigging.

The Engineer

DECEMBER, 3, 1943

VOL. CLXXVI No. 4586

Contents

THE ENGINEER, December 3rd, 1943 PAGE

A SEVEN-DAY JOURNAL 437

LEADING ARTICLES—

THE QUEST FOR ECONOMY 446
RAILINGS SCRAP 446

SPECIAL ARTICLES—

ENGINEERS AND THE BRITISH EMPIRE. No. XXII. (Illus.) 439
LIFE AND WORK OF NIKOLA TESLA. (Illus.) ... 447
NEW METHOD OF SORTING STEELS. (Illus.) 442
SALVAGE OF U.S.S. "LAFAYETTE." No. III. (Illus.) 440

CEMENT IN WAR AND PEACE 453
FLEXIBLE 65-TON PNEUMATIC PRESS. (Illus.) ... 445
GYROSCOPIC PRINCIPLES AND APPLICATIONS. No. II. (Illus.) 452
HIGH-PRESSURE SUPERIMPOSED POWER PLANT. No. I. (Illus.) 450
ROAD RESEARCH IN WARTIME 444
SEVERN BARRAGE SCHEME 449

LETTERS TO THE EDITOR—

DAYWORK OR PIECEWORK 449
FUSION OR CO-ORDINATION OF TECHNICAL SOCIETIES 449
OIL ENGINE OUTPUTS 449
HYDROGEN IN BOILERS... 449
ADVERTISING AND CLASSICS... 449

NEWS AND NOTES—

AMERICAN ENGINEERING NEWS 454
FORTHCOMING ENGAGEMENTS 456
MARKETS, NOTES AND NEWS 455
NOTES AND MEMORANDA 456
SIXTY YEARS AGO 445

NOTICES TO READERS

Paper restrictions make it impossible to increase the number of subscribers. New subscriptions can in future only be accepted for inclusion on the waiting list.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper or described in its editorial columns should not be taken as an indication that they are necessarily available for export.

**** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

**** For Subscription Rates, see page 2 of Advertisements.*

**** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have both old and new address, as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

THE QUEST FOR ECONOMY

EVEN before the war much was heard of Germany's *ersatz* commodities, which were often of such a low standard as to bring the term into reproach. Yet the practice in itself is innocuous. The substitution of one article by another may be dictated by a variety of causes, and perhaps the greatest urge has been that of sheer necessity, which is generally accepted to be the mother of invention. This country has been robbed of its supplies of raw materials in more than one way, partly by the difficulties of overseas transport, but still more seriously by the sudden loss of raw materials through enemy action—of which no better example could be instanced than that of rubber—with the result that it became absolutely imperative to develop alternative materials in a minimum of time. From the outset it was endeavoured to make the substitute not only as efficient as the article replaced, but, if possible, much better, and it is good to know that many results have been obtained which more than justify the thought and work devoted to the subject. Closely allied is the question of economy, or putting the limited supplies available to the best use possible and ruthlessly eliminating all waste.

This whole consideration was very suitably ventilated by the Ministry of Supply in its exhibition entitled "A Great Achievement," staged in London a few months ago, which clearly set out the story in such a way that even the most casual observer could hardly fail to be impressed. It was a story almost without words, although the actual savings in material and man power were clearly indicated, and the natures of substitution displayed by samples. The reason for drawing attention to this display at the present time lies in the fact that the exhibition proved so effective that it was decided to widen its scope, and under the auspices of Regional Boards to arrange for similar exhibitions to be held in various industrial centres. As one of the many arresting examples might be mentioned the ordinary high-explosive shell, of which so many millions were fired in the last war, each of which had to be bored to size, a laborious operation involving a large number of special duty lathes. At the present time all such shells have unmachined cavities, being successfully forged within the limits allowed. By this means some of the slowest machining operations have been eliminated, with an enormous saving in materials, tools, and man power. As a single example it may be of interest to state that in one range alone 400,000 tons of steel and 18 million man-hours have been saved. In spite of all the special demands of war, the consumption of paper and timber has been reduced to one-third of the pre-war figure, and whereas before the war practically all this material was imported, to-day large percentages are produced in this country. Perhaps even more spectacular is the development of welding in place of riveting, and of fabrication methods in substitution for complicated forgings and castings, resulting in remarkable savings in material and machining, thus releasing labour for other urgent work. Most engineers have a general conception of the great strides made in welding in recent years, so that some of the most conservative advocates of riveting have been at last converted; but there is nothing like ocular demonstration to convince the sceptic, and furthermore to suggest new avenues of approach. As a final instance we will pass from the mountain to the mouse and take the common cotton reel, which has been more or less a standardised product for many years. By shortening the overall length and at the same time reducing the inner diameter, the same length of cotton or silk can be accommodated, but there is a saving of wood which results in the aggregate to no less than 6000 tons per annum. Great though the savings effected by the careful study of material are, another side of the question that does not receive the attention it deserves is the drastic elimination of everything that savours of "spit and polish." We have all become quite accustomed to the legend "war finish," which appears on many of our machine tools to-day, but it will come as a shock to some to realise the number of man-hours that can be wasted by putting an unjustified finish on such common articles as the fork and spade so evident on the wartime allotment. In the exhibition the old and the new side, by side, narrate their own story, and carry conviction in an unanswerable fashion.

No less enlightening is the story of the substitution of one material for another, and perhaps the most outstanding is to be found in the British wooden aeroplane, the Mosquito, which has already attained fame and more than justified a revolutionary return to an older material. The substitution of one substance for another is, however, too big a one to approach at the end of a story told with the intention of awakening interest and stirring the imagination to develop an economical outlook and a departure from that conservatism which would aver that "what was good enough for my father is good enough for me." The exhibition to which we have alluded lays down no laws, imposes no strictures, but is set out in the form of a story that is lavishly illustrated with examples and comparisons that effectively speak for themselves. It is suggested that all industrialists who can do so should take the opportunity of seeing this exhibition, imbibing its morals, and then quietly working out the application of its principles in their own organisations.

Railings Scrap

AMONGST the mysteries of the war which interest a considerable proportion of the inhabitants of this country are details of the transaction by which they lost the railings that guarded their premises, and at the same time local authorities were deprived of the railings that protected their open spaces. To the majority of these owners the sequence of events was somewhat as follows:—One day a printed notice was posted up in their locality, stating that under the Defence Regulations any railings in the district might be taken by the appropriate authority. Then followed a visit from workmen, who, with cold chisel or acetylene blow-pipe, removed that portion of their railings above ground. It usually followed that these workmen were identified sooner or later with a neighbouring firm of builders or scrap merchants, who in peacetime might be expected to undertake such work and, so far as the householder was concerned, all that remained to him of his property was a memory, sweet or otherwise, according to the artistic character of the railings. If he pressed the matter to the length of inquiring from his local town officials, he was usually informed that his lost property was required to make material for the production of tanks, guns, submarines, &c., anything, in fact, made of iron and steel which was used for warlike purposes. This was a perfectly true statement, and the problem which the requisitioning of the railings was intended to solve was a shortage of scrap in this country which followed the cessation of shipments from the United States. In fact, one of the first urgent problems the Iron and Steel Control had to face after the war began was the supply of sufficient scrap to meet the enormous demand

of the iron and steel works. The Government, faced with a famine of this essential material, acted promptly and resolutely. A deadline beyond which it might be expected that the war would not last was fixed and a drive was made to accumulate sufficient supplies of iron and steel scrap to carry the industry through to that date. The period envisaged has not yet elapsed, and although the scrap market may become tight, there is no fear that starvation conditions will develop. The individual householder, however, was not told by what process the railings reached the ultimate consumers, the iron and steel works. It is not surprising, therefore, that many dispossessed householders feel that they have been treated with an unnecessary lack of consideration.

The owners of railings were offered 25s. per ton for them as scrap. The steel works, of course, pay more, and from the difference about 10s. is absorbed in the expense of collecting and preparing the material for the steel works' use. The railings collected throughout the country totalled a considerable tonnage, something in the neighbourhood of 600,000 tons, and a very big proportion of this has already been used, so that the money involved is over a million pounds. In many cases the local firms employed to remove the railings were short of labour and had to engage inexperienced workmen, with the result that considerable damage was done to the foundations where railings were set in brick or stone, and although this damage was restored at the public expense and at a considerable cost, it caused a feeling of irritation that has taken a long time to subside. It would appear, however, to have been unavoidable when the work was done under the conditions which existed. If the whole question of the removal and collection of the railings is carefully considered, it will be seen that the authorities were not so greatly to blame as would appear at the first glance. The Ministry of Supply took action to obtain the railings by compulsory acquisition after an appeal to owners voluntarily to give up their property, which was tried out in a few districts had obviously failed to bring the desired results. The Ministry of Works came into the picture as the agent of the Ministry of Supply and was responsible for the collection. The latter Ministry put into operation a carefully considered scheme. Local authorities were required to make a schedule of the railings in their district, which was considered by the Ministry. In cases in which the schedule failed to give satisfaction, either by failing to provide the expected quantity or in some cases by going too far, steps were taken by the Ministry to ensure that adequate and reasonable quantities were received from any particular locality. At the same time, a panel of experts was set up at the Ministry of Works to consider cases in which railings of artistic merit were threatened. There is no doubt that some owners felt that they were being badly treated in not being offered more than 25s. per ton and still remain under the impression that they have no right of appeal against this price. The position, however, is that any owner who objects to the price can refuse to accept it and can appeal to a Compensation Court. Another source of complaint by owners against the Government's method of collection has been that there was no notification to individuals beyond the general posting of the notice that railings would be requisitioned. This was the case at first, but for some time now the collecting firms have been instructed to warn the owner when his railings will be removed and forms for this purpose have been distributed to the collectors by the Ministry of Works.

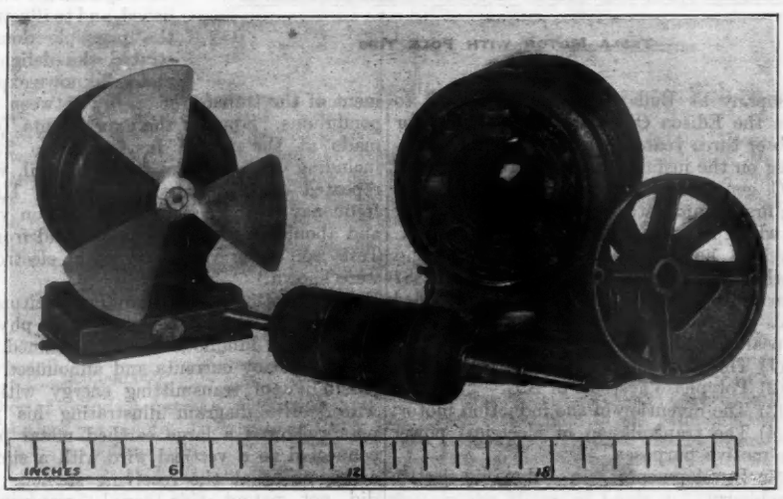
The scheme for collecting the railings appears to have been framed with a view to causing as little inconvenience as possible to the owners, but it had to be put into effect by numerous local councils, and there appears to have been a lack of uniformity in the way in which they interpreted their instructions. It is probable that the mistakes which have been made were largely due to this. It may be argued, with some reason, that the fact that 90 per cent. of the dispossessed owners have not claimed any payment shows that there was no great objection on the part of owners to give up their property. On the other hand, the public have never been informed of the circumstances under which they could make a claim; at any rate, not with the same clearness as they were told how to claim against war damage. Apart from the question of payment, however, there are possibilities of future trouble, which should be cleared up before it arises. Cases have occurred in which the removal of railings has led to accidents to pedestrians and vehicles, and it seems to be a moot point as to who is responsible for any legal damages, or whether they come under the heading of "fortune of war."

Life and Work of Nikola Tesla

AT the Institution of Electrical Engineers, on Thursday, November 25th, Dr. Fleming presented a commemorative lecture on the "Life and Work of Nikola Tesla." A number of demonstrations of apparatus and of experiments similar to those which from time to time Tesla himself had performed when lecturing were made. In what follows we give some notes of the lecture.

Nikola Tesla was born on July 9th, 1857, in the village of Smiljan, in Yugo-Slavia, near the border of the old Austro-Hungarian Empire. The village is situated about 30 miles north of Zara, on the Dalmatian coast. Tesla's father, a Serb, was a priest of the Greek Church and the son of an officer of the Grand Army of Napoleon. Tesla probably inherited some of his inventive genius from his mother, who herself showed great inventive capacity in connection with the improvement of agricultural and other implements. Tesla's early education was obtained at the local town of Gospic, and later he spent three years up to the age of sixteen at the Higher Real School at Cartstatt, a not distant town. Here he distinguished himself in mathematics and physics. He then proceeded to the Polytechnic at Gratz, in Austria, where he was keenly interested in electrical engineering. Later he proceeded to Prague University and graduated there at the age of twenty-three. In addition to his technical studies he had by this time become a very accomplished linguist.

Tesla's physical constitution was not robust, and on two occasions he nearly died before reaching manhood: once from cholera and later from a nervous breakdown due to over-study. During his convalescence after the first of these occasions, he obtained his father's consent to be allowed to pursue an engineering career instead of entering the Church, as his parents had desired. During his study at the Polytechnic at Gratz he became very interested in the behaviour of the Gramme dynamo, and he endeavoured to solve the problem of obtaining a commutatorless machine. Much has been written in books and scattered papers about Tesla's life and work, both in the U.S.A. and in this



TESLA INDUCTION MOTORS

country, and on the occasion of his eightieth birthday spent at Belgrade, many addresses and papers were discussed presenting the technical details of his inventions. To-day, it is proposed to direct attention to the contribution which Tesla's work made to the advancement of human progress rather than to review again the details of his many technical achievements.

[The lecturer then reviewed the state of the electrical art at the time of the beginning of Tesla's career, about 1881, and referred to the contributions of Oersted and Faraday and such designers of dynamo-electric machines as Holmes, Wilde, Siemens and Gramme. The invention of the incandescent lamp and the Edison dynamo were also mentioned, and a picture drawn of the state of power generation and distribution. Attention was drawn to the limitations of the use of electrical power by the D.C. system owing to the limited distance of transmission, and by the A.C. system owing to the unsatisfactory behaviour of the A.C. motor.]

Tesla first took up work at the Telephone Company at Budapest, then proceeded to join the Edison Company in Paris, and for two or three years worked there or in Strasburg on the installation and maintenance of D.C. generating machinery. Here he made his first commutatorless machine, the theory of which he worked out while in Budapest. In 1884 he proceeded to the U.S.A. and worked with the Edison interests. In 1887 the Tesla Electric Company was founded and the following five groups of patents appeared within the next couple of years :—

(1) The discovery of the rotating field.

(2) Polyphase systems of A.C.

(3) The invention of the induction motor.

(4) The transmission of electrical power for motive purposes.

(5) Developments in dynamo-electric machinery.

[Slides were thrown on the screen and experiments were performed to illustrate Tesla's work in these fields.]

In 1888 the Westinghouse Company acquired the groups of Tesla patents relating to polyphase systems, the rotating magnetic field, induction motor design, &c., and in 1893, at the Chicago Fair, power was supplied by a two-phase generator driven by a 500 H.P. induction motor which supplied current for lamps, motors, and by means of rotary converters and motor generators to all sorts of D.C. apparatus.

Meanwhile, an International Commission was investigating plans for the harnessing of the Niagara Falls. It failed to decide on a scheme, although the most promising appeared to be one based on the Tesla polyphase system. In 1893 the Westinghouse Company undertook to build three 5000 H.P. Tesla generators and later seven more units, making a total of 50,000 H.P. equipment for the purpose, an undertaking subsequently carried out.

Tesla, having worked with the Westinghouse Company for two or three years designing induction motors and polyphase equipment, returned to New York and commenced his investigation of high-frequency phenomena based on the work of Hertz, who had demonstrated the existence of the electromagnetic waves predicted years previously by Clerk Maxwell. He constructed a rotating alternator giving current at a frequency of 3000 kilocycles, but this kind of machine found no real use until about 1910. Tesla seemed to have the idea that some new mechanism of transmission would emerge if he could get high enough frequency and voltage, and he set himself the problem of achieving this by means of electrical oscillations in a circuit containing a low-frequency A.C. source, an induction coil, condenser, and spark gap.

TESLA MOTOR WITH POLE TIPS

[The lecturer then gave a description of a simple electrical circuit and how its natural frequency could be varied or tuned to that of another circuit, thus leading up to the principle of the Tesla coil. He showed a diagram of the Tesla coil, in which for the first time the principle of tuning as an essential factor in a radio system was established, and to illustrate the principle demonstrated the delightful and well-known experiment of the transfer of energy between two pendulums. Some of the experiments Tesla made at the Royal Institution in 1892, including displays from the Tesla coil, were repeated on about the same scale. High-frequency discharges at half a million volts and about 100,000 cycles per second from a Tesla coil using various types of electrodes were shown.]

At a meeting of the Franklin Institute in March, 1893, Tesla demonstrated the physiological and luminous effects obtained by high-frequency currents and announced the possibility of transmitting energy without wires. His diagram illustrating his proposals showed a large earthed metal plate connected to a vertical wire with a similar arrangement at the receiving station. He did not patent this aerial arrangement, although it appears to be the first use of an antenna system.

In 1896 he succeeded in transmitting signals without wires for a distance of 20 miles, and in 1898 he constructed a small ship which he succeeded in directing by radio from the shore.

Tesla appears to have conceived the idea of causing the whole terrestrial globe to oscillate electrically and thereby provide a system of what he termed "world wave telegraphy." He seems to have visualised exciting a free oscillation of charge on the earth's surface, and hoped it would convey large amounts of power over great distances. With this in mind he erected in Colorado in 1899 a high aerial tower and connected to this a very high-voltage Tesla coil between it and ground. The mechanism of propagation he was seeking was not the mechanism which Hertz and Maxwell thought of and which is used to-day, but his method did involve the employment of a high aerial and ground connection, two of the most obvious features of present-day radio. He transmitted power sufficient to light a neon lamp at a distance of 30 kiloms. and produced detectable signals at a distance of 1000 kiloms.

Some years after the experiments at Pike's Peak he built the famous tower on the beach at Long Island, which was some 200ft. high, surmounted by a metal sphere, 70ft. in diameter, designed to stand many millions of volts at high frequency. He called it a "magnifying transmitter," and spoke of broadcasting telegraphy, speech, vision, and power. His concepts of its action are not clear. The tower was never completed and was dismantled about 1915.

Reviewing Tesla's outstanding achievements, those of the most direct value to mankind related to the development of the polyphase electric system of generation and transmission, which is the basis of that used all the world over to-day, and the discovery of the rotating magnetic field and its applications to the design of A.C. motors. These two inventions facilitated an enormous development of electrical power generation, distribution, and application. Minor achievements in connection with the power side of electrical engineering were his contributions to the development of transformers, switchgear, meters, and arc lamps. In the field of high-frequency electrical phenomena his contributions have been of importance mainly in extending the field of knowledge of the subject rather than in the introduction of inventions of far-reaching importance. He laid the foundations of knowledge and developed apparatus which was brought eventually to commercial success by others, and for which he received little material reward and inadequate recognition. He invoked the principle of tuning and appears to have been the first to use a transmitting aerial and receiving antenna tuned to the same frequency. He conceived the idea that the upper conducting layers of the atmosphere might be helpful in the transmission of radio signals. He studied the physiological effects of high-frequency phenomena and their application to bloodless surgery. He experimented in the production of ozone and other gases, and constructed, among other devices, electrostatic condensers, frequency meters, &c.

Tesla died on January 7th, 1943, in New York, at the age of eighty-six. He is described as being very tall, very thin, plainly dressed, and immaculately groomed, and of delightful courtesy and charm. Dr. Eccles, in his appreciation of Tesla, says : "His genius lay in conceiving broad schemes, in inventing means—ingenious means—of carrying them out, and in designing and building apparatus to prove them practicable."

PRIZE FOR ESSAY ON WELDED SHIP DESIGN OR CONSTRUCTION.—The Council of the Institution of Engineers and Shipbuilders in Scotland offers for competition a prize, presented by Mr. J. L. Adam, for a paper or essay on the design or construction of welded ships. The competition is open to students of the Institution or any other persons between the ages of eighteen and twenty-five who have had shipyard experience. Entries should be so written that they can be read as papers before a meeting of the Institution or a section thereof. Entries should be sent to the Secretary of the Institution, 39, Elmbank Crescent, Glasgow, not later than February 18th, 1944.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

DAYWORK OR PIECEWORK

SIR,—Lord Perry raises a problem which is one of considerable division of opinion. Curiously enough, his opposition to piecework is generally shared by the trades union movement, and the principle which he advocates of a minimum rate of wages is one for which they have always fought. No trade union has objected to a man getting more than the minimum, and indeed this is the practice in the best engineering shops. During times of peace there is usually not enough work to go round, and it is morally bad to allow men to deteriorate in unemployment while others are overworking under the stimulation of piecework. In war, however, we must bow to the fact that no method can obtain the same results in some cases as does "payment by results," and it would appear that in many industries the system has come to stay.

I myself cannot agree that the quality of work is determined by the system of payment. More depends upon the character of our people. I have known engineers who were temperamentally incapable of doing a slipshod job, and I have known others who were good fast workers, whether on piece or time.

The crux of the problem, in my opinion, lies in character. If we so train our children that they have to accept no responsibility, but do as they are told, then the responsibility for accuracy and good work becomes one for the supervisors who in turn may depend on their supervision. The modern Army has had to change that approach and make men self-dependent with a commando spirit. The Army are now treated as men and not children. So must it be in the workshop. The status of workers must be raised. There must be a sharing of the responsibility with the men. So long as the employers insist that the men are not concerned with what happens in the works, then the men will accept that view and leave it to their employers to ensure efficiency, check slackness, and boss the show.

My view is that industry ought to be the concern of all in it. The more the new generation of workers feel they are part of an industrial army, playing their own valuable part, the more their dignity and self-respect will rise. General Montgomery has revolutionised the spirit of his Army because they feel he takes them into his confidence and they know their goal. Formerly the soldiers only heard what they had been fighting for from the wireless after they had succeeded or failed. This succeeds in workshops, where it is tried with good sense on both sides. There, however, should not be "both sides." Industry should be one organisation, where it works as a team, and everyone knows his part of the field, and where everyone knows the goal. Secrecy breeds suspicion, and that is the enemy of co-operation.

The key to success in the workshop starts in the schools. It is there that self-reliance and character must be established. Drill-sergeant education produces servile and evasive workers. Education must produce good citizens, anxious to do their bit in the world.

ARTHUR WOODBURN.

November 29th.

FUSION OR CO-ORDINATION OF TECHNICAL SOCIETIES ?

SIR,—Engineering, architectural, and accountancy associations, which are all multiple bodies, have begun to recognise the need of co-ordination; indeed, are seriously discussing it. These three occupations differ somewhat in character. Every architect is concerned with structures, so that there is no need for the existence of several architectural bodies. In their case fusion seems the obvious principle. In like manner all accountants are concerned with accounts and the argument applied to architects applies equally to them. In the large number of engineering societies—a number which would surprise the uninitiated—the case is different. For example, marine engineering is different from civil engineering, mining engineering from radio engineering, aeronautical engineering from electrical engineering. Indeed, a large number of such societies are specialist societies, which have rightly become established as such. The case then of these varied societies is a case for co-ordination and not fusion, and that is the method now being pursued by some active spirits amongst them.

It is recognised by some that it is desirable to federate the three great multiple organisations of the engineers, the architects, and the surveyors, by reason of the considerable affinities between them. But I go further and wish to see a federation of all professional bodies, not only on account of various points of contact between them, but for the purpose of examining and controlling fees, supervising examinations (in this case, perhaps, under State direction), protecting their general interests, as do the trade unions, and other purposes. It cannot be appropriate for a civilised State to allow the upspringing of associations covering ground already covered nor the persistence of such bodies already in existence.

Life is very complex and increases in complexity. It is desirable, therefore, that unnecessary complexity should be eliminated.

A. W. CRAMPTON.

8E, Woodchurch Road, N.W.6,
November 24th.

OIL ENGINE OUTPUTS

SIR,—With reference to your leading article of November 19th, on "Oil Engine Outputs," it may be of interest if I point out that my old petrol engine formula gives a very near figure for the B.H.P. of any double-acting oil engine, and can be used to judge whether a given engine is up to, under, or above average efficiency.

The formula is $\frac{n\,l\,d^2\,r}{12{,}000}$, where dimensions are in inches, and $\frac{n\,l\,d^2\,r}{200{,}000{,}000}$ for millimetres, n being number of cylinders, l stroke, d diameter, and r revolutions per minute. It assumes an M.E.P. of 84·5 lb. per square inch.

C. F. DENDY MARSHALL.

Guildford, November 24th.

HYDROGEN IN BOILERS

SIR,—After reading the letters in your issue of November 5th and November 19th, I realised with regret that my attempt to compress my remarks into the least possible number of words had given rise to further misapprehensions.

In the first place, the loose scale referred to in my letter of October 26th was not that scale which is deposited in boilers when impure feed water is used, but what might very well be described as mill-scale, and consisted of thin flakes of partially oxidised iron. The boiler was provided with the usual zinc slabs, and no electrical protective system, such as that described by Mr. Lingley, was employed.

So much for the observations that left no doubt in my mind that hydrogen had been generated, and I turn now to the question of its accumulation.

I did not wish to burden my audience with a detailed description of the ventilating system, but it now seems desirable to explain that the fan motor was in a compartment through which access was obtained to the engine-room. This compartment was at the side of the air down-take to the fan eye, whilst the fan delivery was trunked to the deck over the engine-room. The top part of this space, into which the air pump breathing pipe was led, formed quite a large pocket, from which gases lighter than air had no escape in an upward direction.

In conclusion, may I add that when embarking on the task of writing my address I modestly hoped that my experiences would prove to be sufficiently uncommon to be of some interest ?

Never, for one moment, was I so optimistic as to think that any of them would prove to be so uncommon as to be unbelievable.

GEORGE PREECE.

Blackheath, S.E.3, November 30th.

ADVERTISING AND CLASSICS

SIR,—I wonder if you have realised that your paper recently, apart from having its customary and well-deserved recognition from an engineering point of view, must have caused interest to anyone with even a smattering of knowledge of the classics. I am making reference, of course, to your advertisement columns. Take your present issue. I find a "Nova ratio" for driving upright piles, a "ΔΕΣΩΤΤΕΡ" advertising a light-weight tool, and incidentally apologising for a previous mistake in the plural of *Πους*. Then I find a ΠΝΕΩ pump, which appears to be aptly named, but I am afraid I cannot reconcile an Arkon (*Αρχων*), a chief magistrate of old Athens, with a flow indicator.

It is quite a refreshing change to turn to a zoological frame of mind and to learn of the "pachydermatous quadruped."

W. WILD.

Leeds, November 22nd.

The Severn Barrage Scheme

REPLYING to a question in the House of Commons, on Tuesday, November 30th, Major Lloyd George, the Minister of Fuel and Power, stated that he had invited three eminent engineers, whose names, he said, he hoped to announce shortly, to form a technical body to consider the Severn barrage scheme. The terms of reference, Major Lloyd George announced, would be: "To review the conclusions of the Severn Barrage Committee in the light of later engineering experience and practice, and of other developments, and to suggest what modifications, if any, should be made in the proposed scheme, in the programme for its execution, and in the estimates of its costs." It will be recalled that in a Journal note of March 23rd we summarised a discussion of the Severn barrage scheme, which took place in the House of Lords on Wednesday, March 17th. On that occasion Lord Brabazon called attention to the possibility of tidal harnessing for the generation of electric power, and in particular drew attention to the report of the Brabazon Committee on the Severn barrage scheme of 1933. Lord Brabazon pointed out that a million horsepower was available, under this scheme, for the good of the country people and for towns and industries. He drew attention also to the increase in the price of coal since the report of 1933 was drawn up. Lord Brabazon was supported by Lord Bledisloe and Lord Sempill. In his reply for the Government, Lord Templemore emphasised the long-term nature of the scheme and expressed the desire for clearer indications of what was likely to be the level of post-war prices.

A High-Pressure Superimposed Power Plant

No. I

(1) Existing Arrangements

THE central generating station of a large colliery undertaking consisting of three 40,000 cubic feet per minute turbo-compressors, 7000 H.P. each, two 12,000-kW turbo-alternators, and one 6000-kW turbo-alternator, and twelve 35,000 lb. per hour water-tube boilers, operating at a pressure of 350 lb. per square inch and a temperature of 750 deg. Fah., was commenced in 1919 and completed in 1922. The station is electrically interconnected with four other power stations belonging to the company.

(2) Primary Considerations

In order to produce duff coal which would meet the demands of power engineers throughout the country and also to enable the colliery company to improve the efficiencies of its washeries, it was decided to de-dust certain coal below 2in. before taking it to the washeries, the dust extracted being minus 60 mesh.

The adoption of de-dusting left the company with a product difficult to dispose of, and it was therefore considered essential to find some means of utilising this dust so that the total realised value of the dustless coal produced would be maintained at the highest possible level. A de-dusting plant was already in operation at one of the company's washeries, the dust from this plant being pulverised and utilised in pulverised fuel-burning boilers at an adjacent generating station.

The central power station, however, was equipped with chain grate stokers on which duff coal and coke breeze were burned and dust was therefore not a suitable fuel for use on this equipment.

Three alternatives were considered:—

(*a*) The conversion of the existing boilers to pulverised coal firing.

(*b*) The installation of new boiler plant suitable for pulverised coal firing, operating at a station pressure of 350 lb. per square inch.

(*c*) The installation of high-pressure boilers suitable for burning pulverised fuel and operating at 1500 lb. per square inch, the high-pressure steam passing through a high-pressure turbine, and, after reheating, to the existing 350 lb. pressure steam mains.

These alternatives were carefully investigated and it was decided to install the high-pressure boilers. Design data are given in Table I, and in Table II comparison is made of the pre-existing plant with that now installed.

(3) Thermal Economies at 1500 lb. per Square Inch

The increased thermal efficiency of the station can be readily visualised from a comparison of the above entropy diagrams.

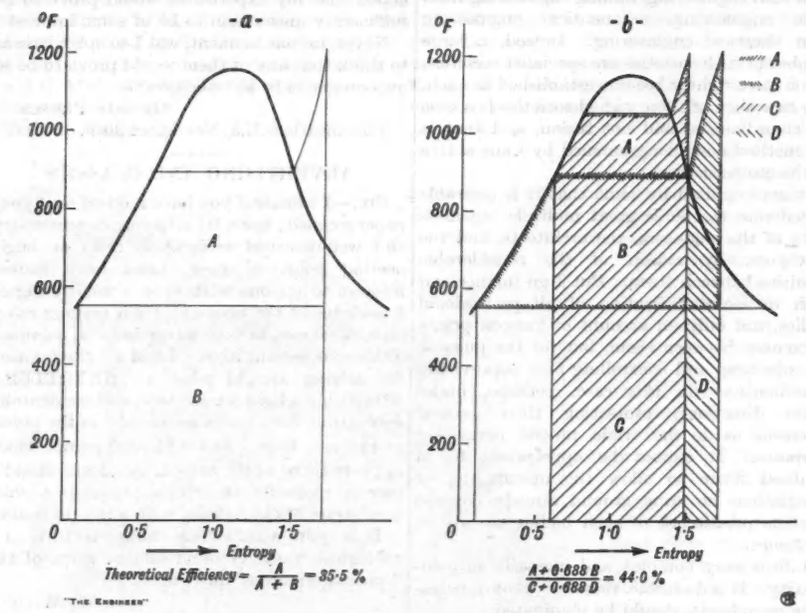


FIG. 1—COMPARISON OF ENTROPY DIAGRAMS

Fig. 1 (*a*): Entropy diagram illustrating the steam cycle of the existing plant with the turbine working at 340 lb. per square inch, 750 deg. Fah., and a vacuum of 28½in.

Fig. 1 (*b*): Entropy diagram showing the steam cycle of the compounded plant (high-pressure turbines working at 1500 lb. per square inch, 750 deg. Fah., exhaust pressure 340 lb. per square inch, and condensing turbines working at 340 lb. per square inch, 750 deg. Fah., vacuum 28·5in.). This diagram also illustrates the effect of reheating part of the high-pressure exhaust steam before being passed to the low-pressure turbines, the balance of the exhaust steam being used for high-pressure feed-water heating.

Although the above diagrams are based on theoretical efficiencies, they indicate the considerable advantages accruing from the adoption of superimposition.

(4) Initial Problems

The installation of the two boilers presented certain difficulties, which influenced the lay-out of the plant considerably, and they were generally as follows:—

(i) The transport of dust from the dust-collecting plants at the various collieries to the boiler plant, together with the handling of the dust at the station.

(ii) It was considered necessary to burn low volatile fuel, necessitating a particularly large combustion chamber, thus increasing the height of the whole boiler plant, which resulted in an increase in height of the boiler

TABLE I.—*Design Data*

Number of high-pressure boilers	Two
Normal rating, each, lb. per hour	110,000
Maximum continuous rating, each, lb. per hour	130,000
Peak rating, each, lb. per hour	150,000
Steam pressure at superheater outlet, lb. per sq. inch	1,560
Steam temperature at superheater outlet, deg. Fah.	770
Heating surface per boiler (high-pressure economiser, evaporator and superheater), square feet	12,200
Medium-pressure steam reheater, square feet	4,700
Total heating surface per boiler, square feet	16,900
Superheater control (high-pressure and low-pressure)	Thermostatic
Furnace volume, cubic feet	7,800
Heat released in furnace (at normal load), B.Th.U. per cubic foot	16,900
Gas temperature leaving economiser, deg. Fah.	700
Feed-water temperature to economiser, deg. Fah.	415
Heating surface of air heaters (two per boiler), square feet	2×14,100
Air temperature leaving air heater, deg. Fah.	500
Gas temperature leaving air heater, deg. Fah.	310
Capacity of forced draught fans (two per boiler), cubic feet per minute	2×32,000
Drive of each forced draught fan	Speed-controlled slip-ring motor
Capacity of induced draught fan (one per boiler), cubic feet per minute	115,000
Drive of induced draught fan	Speed-controlled slip-ring motor
Type of firing	Pulverised fuel
Type of fuel	Coal dust / Coal dust
Calorific value of fuel, net, B.Th.U. per lb.	13,350 ... 12,050
Calorific value of fuel, gross, B.Th.U. per lb.	13,700 ... 12,370
Volatile, per cent.	16 ... 11
Moisture, per cent.	7–10 ... 3
Ash, per cent.	6–8 ... 14–16
Ash-fusing temperature	Non-fusible at 2642 deg. Fah. in both reducing and oxidising atmospheres
Dust-collecting plant	Buell-Van Tongeren
Boiler plant efficiency, per cent.	86
Number of boiler feed pumps	Three
Capacity of each boiler feed pump, gallons per minute	350
Head, lb. per square inch	2,230
Number of high-pressure turbines	Two
Speed of turbines, r.p.m.	3,000
Capacity of each turbine, kW	6,500
Stop valve pressure, lb. per sq. inch	1,500
Stop valve temperature, deg. Fah.	750
Back pressure, lb. per sq. inch	370

TABLE II

	Existing plant, before compounding	New units.	Entire plant, after compounding
Number of boilers	12	2	12
Steam generating capacity, lb. per hour	420,000	260,000	610,000
Number of turbines	6	2	8
Generating plant—			
Capacity (electrical), kW	30,000	13,000	43,000
Capacity (air), cubic feet per minute	120,000	—	120,000
Equivalent capacity in kilowatts	15,500	—	15,500
Total kilowatts	45,500	13,000	58,500
Maximum loading, electrical, kW	16,000	6,500	22,500
Maximum total loading (equivalent electrical), kW	26,100	6,500	32,600
Turbine stop valve pressure, lb. per square inch	350	1,500	—
Turbine stop valve temperature, deg. Fah.	750	750	—
High-pressure turbine exhaust, lb. per square inch	—	370	—
Annual output, electrical and compressed air (sent out), kW	147,568,000	—	147,568,000
B.Th.U. per unit (sent out), B.Th.U. per kW	21,000	—	16,500
Station thermal efficiency (sent out)	16·2	—	20·6
Calorific value of coal (net), B.Th.U. per lb.	12,350	—	12,350
Annual coal consumption, tons	112,248	—	88,200
Low-pressure capacity superimposed, kW	—	15,500	—
Total capacity superimposed, kW	—	22,000	—

house. Owing to space and weight limitation, a light steel structure, which was afterwards sheeted, was erected on the top of the old walls.

(iii) The limited space available, as it was only possible to take out two of the existing 35,000 lb. per hour boilers.

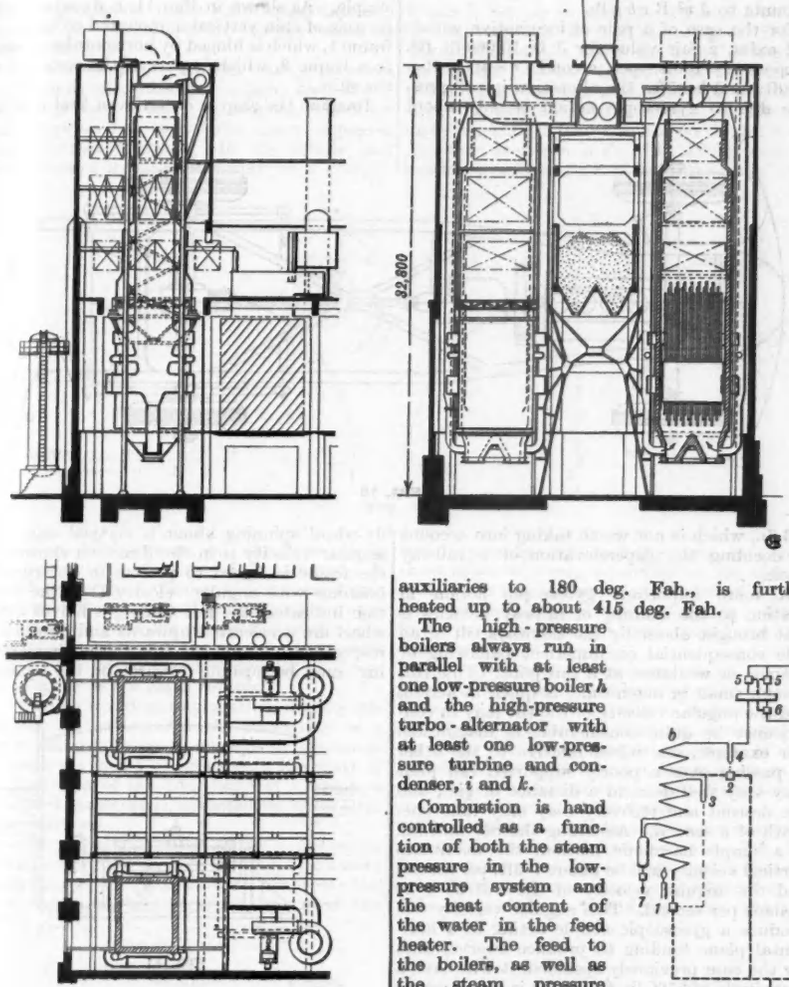


FIG. 2—ARRANGEMENT OF H.P. BOILERS

(iv) Particular attention had to be paid to feed water, as scale could not be tolerated.

(v) The heat balance of the auxiliaries had to be carefully investigated, as with the compounded plant additional steam was available from the interceptor blow-downs of the high-pressure steam generators and from the glands of the high-pressure turbines.

(vi) It was not possible to support any part of the boiler from the existing building and the new boiler plant had to be made completely self-supporting.

(5) OPERATING CYCLE

The working cycle of the plant can be followed from the skeleton diagram, Fig. 3.

Superheated high-pressure steam is generated in the boilers *b* and passed into one of the two 6500-kW turbines *c*, the other being kept available as standby, from which the steam is exhausted at 370 lb. per square inch. About 75 per cent. of this steam is returned to reheaters *f* situated between the superheaters and economisers, where the temperature is again raised to 770 deg. Fah. The steam is then passed to the receivers of the low-pressure plant. The remaining 25 per cent. of the exhaust steam, which is not returned to the reheaters, is taken to a feed-water accumulator (or heater) *d*, where the high-pressure feed, already preheated by steam from the auxiliaries to 180 deg. Fah., is further heated up to about 415 deg. Fah.

The high-pressure boilers always run in parallel with at least one low-pressure boiler *h* and the high-pressure turbo-alternator with at least one low-pressure turbine and condenser, *i* and *k*.

Combustion is hand controlled as a function of both the steam pressure in the low-pressure system and the heat content of the water in the feed heater. The feed to the boilers, as well as the steam pressure and temperature at the high-pressure superheater outlets, are regulated automatically as described later in this article.

In the event of a sudden increase in the station loading the additional load is taken up by the low-pressure condensing turbines, which are provided with standard speed governors. The valves of the low-pressure turbines open, and as there is no momentary change in the combustion conditions, the steam pressure in the low-pressure system drops and with it the pressure in the feed-water heater. The pressure-controlled valve 11 on the feed heater, regulating the quantity of water circulated by the pump *e*, closes and allows less water to be circulated, with the result that the quantity of steam condensed is reduced and correspondingly more steam is passed through the reheaters. Additional steam is thus available for the low-pressure system, allowing the low-pressure condensing units to deal with the increased load on the station.

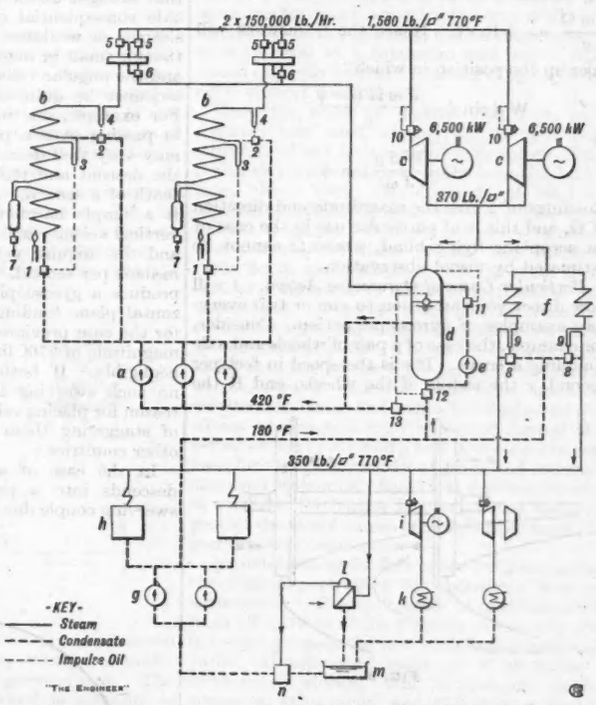
As, however, the quantity of steam condensed in the feed heater has been reduced, while the quantity of feed taken by the high-pressure feed pumps *a* has not altered, the heat content of the water in the feed heater decreases.

The reduction in the heat content, together with the position of the circulating valve, are indicated at the main control board on the firing floor and the rate of combustion of the high-pressure boilers is then increased.

The quantity of high-pressure steam generated is increased and the steam pressure before the high-pressure turbine tends to rise. This turbine is under the control of a pressure governor and consumes at any moment the total quantity of steam available, producing a corresponding supply of electrical energy. Consequently the tendency of the steam pressure to rise causes the nozzle valves 10 of the turbine to open, allowing more steam to pass through the turbine and increasing the electrical load carried by this unit.

The increased quantity of steam passing through the high-pressure turbine naturally increases the steam quantity available in the low-pressure system, and if the rate of combustion has been increased sufficiently, equilibrium is again obtained.

Conversely, a decrease in the station loading causes a rise in pressure in the low-pressure system. More steam is condensed in the feed heater and its heat content tends to rise and the rate of combustion in the high-pressure steam generator has to be decreased until equilibrium is reached.



a. H.P. feed pumps
b. H.P. boilers
c. H.P. turbines
d. Feed heater
e. Circulating pump
f. Intermediate superheater
g. M.P. feed pumps (only two shown)
h. M.P. boilers (only two shown)
i. M.P. turbines (only two shown)
k. Condensers (only two shown)
l. Evaporators (only one shown)
m. Hotwell (only one shown)
n. Deaerator

1. Automatic feed control valve
2. Automatic injection valve
3. Thermostat 1
4. Thermostat 2
5. Intermediate pressure regulating valves
6. Intermediate by-pass valve
7. Interceptor
8. M.P. water injector
9. M.P. thermostat
10. H.P. turbine admission valves
11. Feed heater circulating valve
12. Feed heater feed valve
13. Emergency feed valve

FIG. 3—SKELETON DIAGRAM OF PLANT

(*To be continued*)

Gyroscopic Principles and Applications*

By Professor C. E. INGLIS, LL.D., F.R.S., M.I. Mech. E.†

No. II—*(Continued from page 430, November 26th)*

Turn Indicator.—An important application of gyroscopic action is instanced by the turn indicator illustrated in Fig. 8. The inner frame in which the wheel is mounted is loaded so that when the axis of spin is inclined at an angle ψ to the horizontal the couple turning it in its trunnion is $W d \sin \psi$ lb.-ft. The outer framework is rigidly attached to its pedestal. If the pedestal is made to precess about a vertical axis with angular velocity ψ, the inner frame will turn over in its trunnions to some inclined

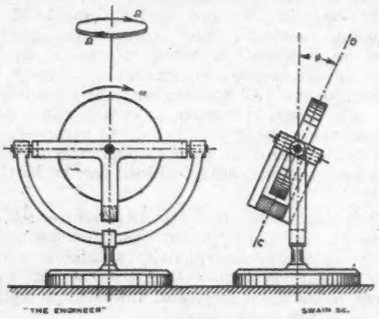


FIG. 8

position ψ. In this position the angular velocity of the wheel about its diameter C D is $\Omega \cos \psi$, and consequently the gyroscopic couple tending to turn the outer frame in its trunnions is

$$\frac{J \omega \Omega}{g} \cos \psi \text{ lb.-ft.}$$

Hence the framework will take up the position in which

$$W d \sin \psi = \frac{J \omega \Omega \cos \psi}{g}$$

or

$$\Omega = \frac{W d g}{J \omega} \tan \psi$$

Readings of ψ give the magnitude and direction of Ω, and this is of particular use in the case of an aeroplane flying blind, where Ω cannot be estimated by visual observation.

Particular Cases of Gyroscopic Action.—I will now direct your attention to one or two everyday examples of gyroscopic action. Consider, for example, the case of a pair of wheels and axle rounding a curve. If v is the speed in feet per second, r the radius of the wheels, and R the

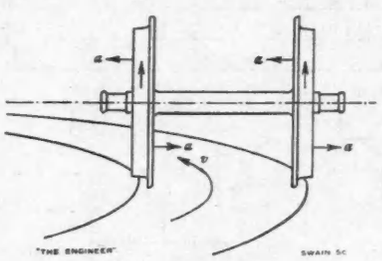


FIG. 9

radius of the curve, both measured in feet. then ω the angular velocity of spin is v/r, and Ω the angular velocity of precession is v/R. For motion in the direction indicated on Fig. 9, precession causes the upper and lower halves of the wheels to accelerate to the left and right respectively; and to provide this the rail pressures must produce a couple $J \omega \Omega = J v^2/R r$ acting in a counter-clockwise direction viewed in Fig. 9, where J is the polar moment of inertia of the pair of wheels and axle. This means that the pressure on the outer rail is increased, and that on the inner rail is decreased, and the overturning tendency due to centrifugal action is augmented. If b is the breadth of the track in feet, this increase and decrease of rail pressure amounts to $J v^2/R r b g$ lb.

For the case of a pair of locomotive wheels and axles, a fair value for J is 10,000 lb.-ft^2. Suppose $v = 100$ft. per second, $r = 3$ft., R = 1200ft., and $b = 5$ft., the alteration in rail pressure due to gyroscopic action is only about 173 lb., which is not worth taking into account in deciding the superelevation of a railway track.

A more important gyroscopic action in relation to the running of railway vehicles is that brought about by the sideways tilt of an axle consequential on imperfect ballasting of sleepers or weakness at a rail joint. This tilt, though small in magnitude, is quick in action, and the angular velocity of the tilt may in consequence be quite considerable in magnitude. For example, one wheel relative to the other in passing over a poorly supported rail joint may very well descend a distance of $\frac{1}{4}$in., and the descent and recovery may only take one-tenth of a second. Assuming the rise and fall is a simple harmonic motion, the maximum vertical velocity will be about 1·3ft. per second and the angular velocity of tilt will be 0·26 radians per second. This angular velocity will produce a gyroscopic couple acting in a horizontal plane tending to produce swerve, and, for the case previously specified, it will have a magnitude of 2700 lb.-ft., which is by no means negligible. If both wheels descend equally, no such swerving is induced, and that is a reason for placing rail joints side by side instead of staggering them as is sometimes done in other countries.

In the case of a motor-car, if one wheel descends into a pot-hole the same type of swerving couple due to gyroscopic action will be induced, and, unless the steering gear is sufficiently rigid and irreversible a succession of such impulses may give rise to that dangerous and unpleasant phenomenon known as wheel "shimmy."

In the case of a motor-car making a turn to the right, as indicated in Fig. 10, the top half of the fly-wheel is accelerated forward and the lower half backwards. Hence, due to precession of the fly-wheel, the load on the back axle is increased and that on the front axle is reduced. A turn to the left has the reverse effect, and in consequence of this increased front wheel adhesion a turn to the left at high speed may be safer than a turn to the right.

Gyroscopic Stabiliser for Ships.—Forces generated by a massive gyroscope can be utilised to check the roll of a ship, and the principle whereby stability is achieved is fundamentally simple. As shown in Fig. 11, a fly-wheel with its axis of spin vertical is mounted to turn in a frame 1, which is hinged by horizontal trunnions to a frame 2, which is part of the structure of the ship.

Imagine the ship is on an even keel and the

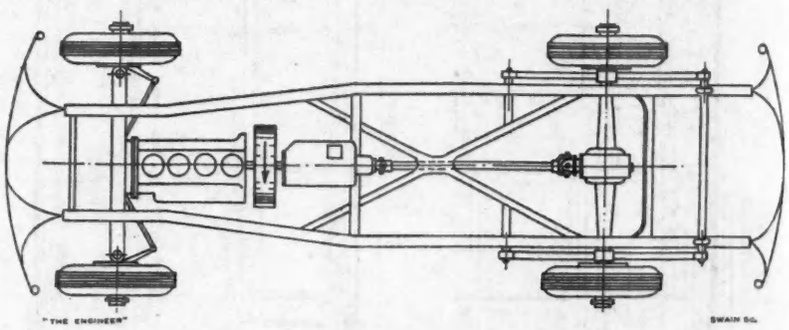


FIG. 10

fly-wheel spinning about a vertical axis with angular velocity ω in the direction shown. If the frame is forced to precess in its trunnion bearings with angular velocity Ω in the direction indicated, the left and right halves of the wheel are accelerated upwards and downwards respectively. To achieve this, the left-hand bearing must be pushing upwards on the trunnion

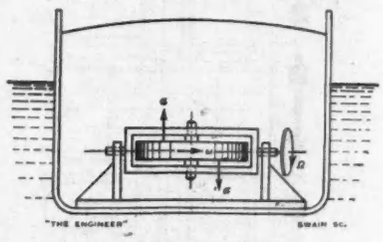


FIG. 11

and the other bearing must be pulling downwards. In other words, the pressure on the first bearing is increased and that on the other is reduced, and this is just what is required to check a roll .to the right. To check a roll to the left, the frame must be given an angular velocity in the opposite direction. If the tilt of the fly-wheel is small, the gyroscopic

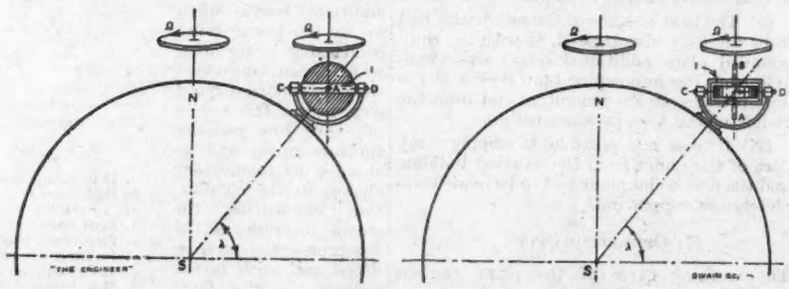


FIG. 12

couple resisting roll has the value $J \omega \Omega$.

Thus if the fly-wheel, 15ft. in diameter and weighing 30 tons, has a polar moment of inertia of 900 tons-(ft.)^2, and if ω is 2400 r.p.m. $= 80\pi$, the couple $J \omega \Omega$ will have the magnitude of about 7000 Ω foot-tons. If Ω is 1 radian per second, the couple developed for resisting a roll amounts to 7000 foot-tons, and this is the restoring couple which could be achieved by

* Institution of Mechanical Engineers. Thomas Hawksley Lecture. Friday, November 19th.

† Engineering Laboratory, Cambridge.

shifting a load of 200 tons across the deck through a distance of 35ft. If the precession is applied before the roll has developed appreciable angular velocity, the couple required to accelerate and rotate the frame in its bearings is little more than that required to rotate it when the wheel is at rest.

In Sir James Henderson's ship stabiliser this precession is effected by a servo-mechanism, which, by means of a variable speed gear, produces a precession of the right magnitude and direction to counteract the couple which is starting the roll.

The Gyrocompass.—Amidst many practical applications of gyroscopic action, one of the most important is the gyrocompass, which for ship purposes has to a large extent replaced the magnetic compass. In its details and refinements a gyrocompass may be a complicated piece of apparatus, but the principle on which it acts is fundamentally simple. It depends upon the tendency of the axis of spin of a gyroscope to set itself at right angles to the plane of a couple acting on the axis of spin, the couple in this instance being provided by gravity which at any given location changes its direction in space as the earth rotates.

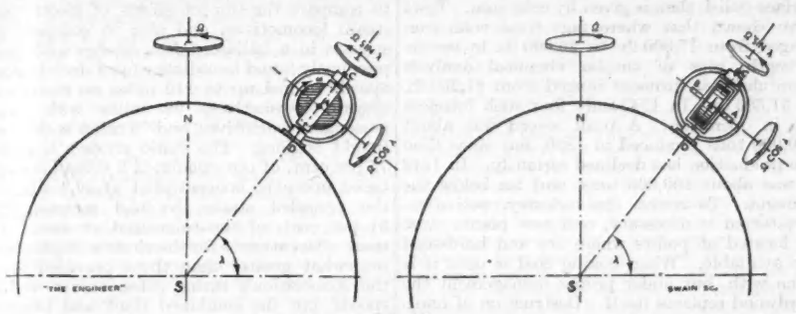


FIG. 13

As leading up to an explanation of the gyrocompass, let us consider the sensitivity of a high-speed gyroscope to change of direction. Although the speed of rotation of the earth is only half that of the hour hand of a watch, a high-speed gyroscope is, nevertheless, quite alive to its existence.

Consider Fig. 12, which shows a gyroscope situated at latitude λ, C D the axis of rotation of gyroframe 1 being in the plane of the meridian and at right angles to the axis of the earth. Owing to the rotation of the earth, the trunnion axis is forced to precess in a plane at right angles to the axis of the earth with an angle of velocity Ω, where $\Omega = \frac{2\pi}{24 \times 60 \times 60}$ is the angular velocity of the earth. This precession will cause the framework 1 to turn in its bearings until the axis of spin is parallel to the axis of the earth, as shown in Fig. 12*b*; that is, in the true north and south direction. If initially the plane of rotation of the wheel is in the meridian, the gyroscopic couple turning the framework in its bearings is $J \omega \Omega$. Even when ω has the high value of 20,000 r.p.m., this couple is only about one two-hundredth J ft.-lb., but if the trunnion bearing is sufficiently free from friction, and gravity forces are accurately balanced, the axis of spin will find the true north and south direction in about 4 sec., the time taken being directly proportional to the rate of spin and almost independent of the value of J. Of course, this arrangement is no use as a compass, since it presupposes a knowledge of the latitude and the direction of the meridian, but it indicates that although you and I have not the requisite sensitivity, a high-speed gyroscope is acutely conscious of the earth's rotation.

A nearer approach to a gyroscopic compass is the arrangement illustrated by Fig. 13. The frame is set up so that its trunnion axis C D is truly vertical, the latitude being λ. Due to the rotation of the earth, the axis C D is given an angular velocity $\Omega \cos \lambda$ in the vertical plane lying east and west, and this will cause A B, the horizontal axis of spin, to alter its direction until it points to the north and south direction, as shown in Fig. 13. If the trunnion bearing is sufficiently free from friction, a high-speed gyroscope will find the north in a very short space of time, depending on the rate of spin, but since the apparatus requires a platform which has absolutely no motion relative to the earth, it could not be employed as a ship compass.

The gyrocompass used on ships is not primarily actuated by the rotation of the earth; indeed, it is supported freely so that it cannot directly feel that movement or any movement of the ship. It only becomes conscious of the rotation of the earth owing to the consequential change in direction of the gravity force acting on a mass attached to the frame.

The general principle on which a gyrocompass acts can be explained by reference to Fig. 14. A high-speed gyroscope is supported so that its axis of spin is free to take up any direction.

As suggested in the figure, this can be achieved by floating the gyroscope mechanism on mercury, and this is the method actually employed in the Anschutz gyrocompass. The framework in which the wheel is spinning is loaded with a mass M. Imagine that the gyroscope is in latitude λ, with the axis of spin horizontal in the east and west direction. If the axis of spin retained that direction in space, then owing to the rotation of the earth the gravity pull on the mass M will gradually change its direction relatively to the gyroscope, and this sets up a couple acting in the vertical plane through the axis of spin which will, in due course, stimulate precession and eventually induce this axis to take up the north and south position shown in Fig. 14*b*. Having got into this position, the changing direction of gravity can no longer produce precession, and the axis of spin remains horizontal, pointing due north and south. Angular movements of the ship will have no effect on the readings if the support is perfectly frictionless, but a change in latitude will introduce an error. For instance, if with the gyroscope axis pointing north, as shown in Fig. 14, the ship moves towards the north, the direction of gravity will be affected thereby, the gyroscope will receive a couple acting in the plane of the meridian, and the compass will deviate to the east or west, the extent of this deviation depending upon the speed of the ship. In a high-speed aeroplane, which has a velocity comparable with that given by the rotation of the earth, this east-and-west error would be quite serious, and consequently for aerial navigation the compasses employed are still primarily actuated by magnetic influence. In ship navigation, to keep the east-and-west error within limits which are negligibly small, the gravity control is purposely made weak, and, in general, it takes a gyrocompass more than an hour to find the north in the first instance. But that is hardly a defect. The great thing is that, having got there, there it will remain *ad infinitum*.

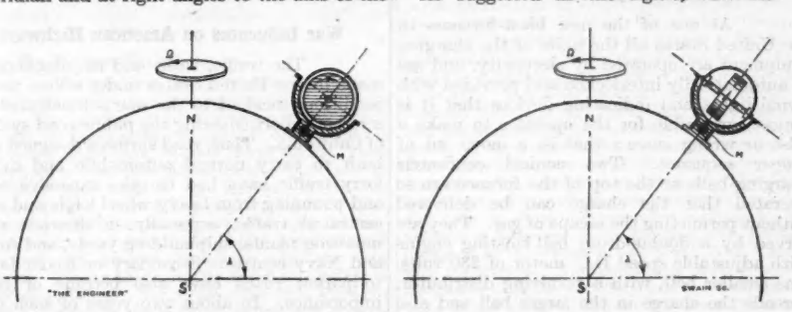


FIG. 14

(To be continued)

Cement in War and Peace

"CEMENT in War and Peace" is the title of an exhibition at the Royal Empire Society, London, arranged by the Cement and Concrete Association. Beginning with the country's need for defence after Dunkirk, the exhibition showed how great a percentage of the total output of the industry was devoted to the construction of concrete shelters, block revetment for protective walling, road blocks, and coastal defence works. The need to reduce the imports of traditional building materials and so release valuable shipping space called for extensive research into the application of concrete, the materials for which are entirely home produced. As a result of this research, timber requirements were reduced to a minimum and where reinforced concrete was used a saving of up to 70 per cent. of steel was effected.

Once the needs of defence had been met, concrete was used extensively for the construction of war factories, military camps, huts, roads, day nurseries, and other essential buildings. Next came the demands of wartime housing and 15,000 houses were built to accommodate armament workers and their families. The majority of these houses had concrete roofs, floors, and staircases. At the same time, a large programme of airfield construction was undertaken. Concrete was used for runways and taxi strips, and hundreds of miles were laid by mechanical plant. The exhibition also provided evidence of the high degree of resistance by reinforced concrete structures—shelters, warehouses, flats, and other buildings—to the effects of fire and high explosive during the period of heavy air raids, and how concrete was used for the speedy repair of roads and railways damaged by bombs. Some less well-known uses of concrete, for barges and for precast slabs to protect the wheel houses of vessels from machine gun fire, were also seen.

An outstanding feature of the exhibition was the section portraying the industry's help to agriculture. The increased output required from all sections of the farming community led to heavy demands for new buildings, roads, and yards. Hundreds of buildings of all types—cowhouses, storage and implement sheds, granaries, stockyards, and piggeries—miles of roads and yards were constructed in concrete. In the Fen districts alone 100 miles of concrete roads enabled more than 50,000 extra acres to be brought into cultivation. A section of the exhibition showed the organisation set up by the industry for the recovery of used paper cement bags, the average monthly collection of which now exceeds 1000 tons. The present rate of recovery within the industry, it is stated, is about 60 per cent., with an average salvage value of more than £100,000 per annum.

In an address at the opening of the exhibition on November 23rd the Chairman of the Association, Mr. Halford W. L. Reddish, said that the cement industry worked on a very small margin of profit per ton. That profit was substantially less to-day than the cost of the twenty

paper sacks in which the cement was packed. While cement must of necessity play a vital part in practically all forms of building and constructional work, both in peace and war, it represented a very small part of the total cost. Even in large reinforced concrete work the cost of cement was unlikely to exceed 8 per cent. of the total. In most cases it was much less. In the case of the new reinforced concrete Waterloo bridge, for example, the cost of cement was less than 2½ per cent. of the contract price, and even that included the not inconsiderable item of transport to the site. In the average small house the profit to the cement industry on the cement consumed was a matter of shillings only.

In the pre-war years the demand for cement was steadily growing and the productive capacity of the industry was always maintained year by year ahead of the demand. In the five years before the war, for example, obsolete and uneconomic plants with an annual capacity of less than 125,000 tons were scrapped and were replaced by efficient modern plants with a capacity of no less than 2½ million tons. Since 1924 there was a steady and consistent reduction in the price of cement to the consumer, notwithstanding the fact that from 1933 onwards the price of coal was steadily rising. It required nearly half a ton of coal to produce a ton of cement, but only in 1938 did the continuing rise in coal costs force a slight reversal of the downward trend of cement prices. During those pre-war years the industry was able to make substantial increases in the wages of its employees, while it also materially improved the quality of its product.

As soon as war broke out the industry appointed a small War Committee of three, with executive powers to act for it in every way in which it could co-operate with the Government, and the Committee's first act was to inform the Government that no matter what the demand for cement might be, it was not the desire nor the intention of the industry to increase its pre-war profits so long as the war lasted. The entire expert staff of the Cement and Concrete Association was placed at the disposal of the Government, and was transferred at once to the Research and Experiments Department of the Ministry of Home Security, where many members of it were still working. Later, however, some of them were released in order that their services might be the more readily available to other Government Departments.

American Engineering News

Large American Timber Buildings

Under the pressure of war emergency, with the vital need of structural steel for military purposes, timber construction for buildings has had a remarkable development. And this development has been aided by the increasing use of metal "connectors," which supplement bolts and greatly reduce the number of bolt holes in joints. Many timber buildings are notable mainly for their great area and are of relatively simple construction, embodying a combination of columns, beams, and girders. Besides these, however, there are great arched truss hangars for blimps and aircraft. A number of such hangars built for the United States Navy are said to be the largest structures ever built entirely of timber. While most of the large timber buildings are designed for a life of only about five years, the Navy hangars are designed and built as permanent structures. For this reason all the material is treated by preservative processes, and in addition has a pressure treatment with ammonium and boron salts to make it fireproof. Overall size is 1060ft. by 297ft. and 170ft. in height; clear inside dimensions are 1000ft. by 237ft. at the floor and a central height of 156ft. The timber arch trusses, 20ft. apart, are 20ft. wide at the base and 13½ft. deep at the crown. They are seated on low concrete structures, 25ft. wide, in which are formed the workshops, offices, and store rooms. Construction of these great trusses, as well as of timber towers, 300ft. high, has really been made possible by the use of metal connectors, since without them the number of bolt holes required at joints would practically destroy the members. For erection the trusses were assembled in sections, the members already bored and shaped, and these sections were hoisted into place by derricks consisting of travelling timber towers, 150ft. high, carrying jibs or booms 75ft. long.

American Charcoal Pig Iron

Although there is a critical shortage of both charcoal and charcoal pig iron in the United States, it is evident from recent reports that there is need and steady demand for this class of pig iron. It has peculiar properties of its own, which cannot be explained by analysis, but which produce very definite results. For example, in the production of rolling-mill rolls for sheet metal it gives a higher density and surface polish than is given by coke iron. Tests have shown that where pigs from coke iron ranged from 17,000 lb. to 25,000 lb. in tensile strength, pigs of similar chemical analysis from charcoal furnaces ranged from 21,200 lb. to 31,500 lb. In 1943 only four such furnaces are in operation. A peak record was about 630,000 tons produced in 1890, but since then the production has declined seriously. In 1942 it was about 100,000 tons, and far below the demand. To revive the industry, active reforestation is necessary, and new plants must be located at points where ore and hardwood are available. When coking coal is used it is done with, but under proper management the hardwood replaces itself. Destruction of hardwood forests—and all forests—has gone on ruthlessly for years, while comparatively little practical attention has been given to reforestation or the provision of perpetual supplies of wood. In certain sections, however, more cordwood is available now than fifty years ago, and local plants produce charcoal for chemical and other industries. In certain ways, charcoal pig iron is superior to coke pig, and is useful in foundries making grey iron and malleable iron castings, but further research is necessary to determine in what lies the superiority, as well as research to strengthen and develop the industry. That the superiority is recognised is shown by the fact that the charcoal pig commands a premium in prices. At present the Government regulations set a price of about £8 per ton for charcoal pig and £6 per ton for coke pig iron.

Blast-Furnace Operation

At one of the new blast-furnaces in the United States all the units of the charging equipment are operated by electricity, and are so automatically interlocked and provided with signal lights and indicating devices that it is almost impossible for the operator to make a false or wrong move; that is, a move out of proper sequence. Two conical concentric charging bells at the top of the furnace are so operated that the charge can be delivered without permitting the escape of gas. They are served by a double-drum bell-hoisting engine with adjustable speed D.C. motor of 230 volts. The smaller bell, with a revolving distributor, spreads the charge in the larger bell and also acts as a gas seal when the latter is opened to drop the charge. This distributor, driven by a 19 H.P. motor and controlled from the skip hoist cabin, has a six-point rotation in steps of 60 deg. Automatic test rods with selsyn generator follow the stock line of the furnace and make continuous charts of its level. The skip hoist, serving the smaller bell, has two wagons of 200 cubic feet capacity. Both cables are attached to a double drum driven by two motors of 150 H.P. geared for a speed of 450ft. per minute, but adjustable for higher or lower speeds by a variable-voltage motor generator set. Under each coke screen is a weighing hopper of 20 cubic feet or 6000 lb. capacity, filled either automatically or by hand. The scale wagon operator has before him a board having all the control push buttons for keeping the furnace properly filled. An electrically operated scale wagon has its doors operated by compressed air, with a compressor on the wagon. It is so interlocked with the skip that it cannot dump a load into the pit unless there is a skip wagon in place to receive it. As the skip for coke breeze fills, its weight settles it down on a saddle until it trips a switch for a hoist, which raises the skip and dumps its contents into a railway wagon. Water is added to the stock as required from a tank. All motors are well ventilated by conditioned air from an electrostatic dust removal apparatus.

Impact Stresses in Bridges

In its investigation of the effect of impact upon the stresses in railway bridges under traffic, the American Railway Engineering Association has reported tests made on a plate girder bridge of 85ft. span by the Pennsylvania Railroad. This bridge has a ballasted deck, the ballast being laid on a concrete floor poured in place and resting directly upon the top flanges of the girders. The tests were made to compare the impact effects of electric and steam locomotives, and also to compare the stresses in a ballasted-deck bridge with those previously found in ordinary open-deck bridges. Speeds ranged up to 110 miles an hour, with electric locomotives, 99 miles with steam passenger locomotives, and 76 miles with steam freight engines. The static stresses were but 75 per cent. of the calculated live-load stresses, based upon the concentrated wheel loads, and the recorded static live-load stresses were 91 per cent. of the calculated stresses. The track effect stresses for the electric engines were somewhat greater than those provided for in the Association's rating rules, except at high speeds, but the combined track and hammer-blow effects were appreciably lower than those provided for in the rules. The increase in stress due to speed was very small and bore no relation to speed, although larger speed effects have been found in tests on other bridges. The total impact percentages, based upon the recorded static live-load stresses, were appreciably lower than those provided for in the Association's bridge specifications and rating rules. The recorded maximum stresses were generally lower than the calculated static live-load stress. As to comparison with open-deck bridges, which have the ties or sleepers laid across the girders, it is considered evident that the amount of damping on this solid-deck span was greater than that on an open-deck bridge of equal length. This increase in damping is due in part to the cushioning effect of the ballast, and to the higher natural frequency of the span due to the concrete and steel acting as a composite beam.

War Influences on American Highways

The traffic, wear, and maintenance of roads in the United States under severe traffic conditions incident to the war is illustrated by a recent report covering the public road system of California. Thus, road surfaces designed and built to carry normal automobile and motor lorry traffic have had to take excessive wear and pounding from heavy wheel loads and concentrated traffic, especially in districts near munition plants, shipbuilding yards, and Army and Navy centres. Secondary or feeder farm-to-market roads have also become of great importance. In about two years of such conditions the State's Highway Department has had to spend some £2,000,000 on repair and maintenance alone. The total highway system of California is about 100,000 miles, or two-thirds of a mile per square mile, while in other States this figure ranges from 2 to 3 miles. Another feature peculiar to California is that 72 per cent. of its 7,000,000 population is grouped in and around urban communities, and 60 per cent. is concentrated in three such communities, which are widely separated. Out of a total annual freight tariff of £60,000,000 for freight whose origin and destination was within the State, 67 per cent. was paid for motor lorry haulage, and 28 per cent. for railway haulage, the small remainder being taken for express or parcels, electric railways, and waterborne carriers. This is independent of the traffic coming in from adjacent States. Included in the record are some 72,000,000 tons of mineral products, mainly stone and petroleum. In all, inter-State lorry traffic increased 33 per cent. in 1941 and again in 1942.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Portuguese Tin and Wolfram

The disclosure made recently that Germany has been receiving supplies of tin from Portugal is the subject of an article in *Tin*, the official bulletin of the Tin Producers' Association. It was stated in the House of Commons that the tin exported to Germany from Portugal totalled in 1941 45 tons of concentrates and 546 tons of metal, and in 1942 about 600 tons of metal. Supplies of wolfram also had been sent from Portugal to Germany totalling in 1941 1814 tons and in 1942 about 2000 tons. *Tin* points out that the policy of the United Kingdom Commercial Corporation, acting for the British Government, is to outbid the enemies' purchasing organisation to ensure this country's supplies of war material. "Portugal is obviously a key position in the fight of the world belligerents for their essential raw materials. Prices there have naturally soared to unheard-of levels. An American paper recently remarked that it would be a matter of academic interest to know where tin was commanding the highest price. 'We suspect,' it added, 'it is in Portugal, where we have authorised preclusive buying to prevent this and other strategic materials from going to the Axis.' Wolfram, according to another authority, was 'bid up' from £300 a ton to £6000 a ton. There can be little doubt that the war demand for tin has been largely fulfilled as regards Portugal by the cumulative efforts of small producers. Grubbing around for tin and wolfram ores has, in fact, been described as a 'popular pastime' for the Portuguese, who are not unnaturally attracted by the fantastic prices which the rival belligerents are prepared to offer. Many of these small people are going one better and trying their hands at smelting, safe in the assurance against loss provided by unfailing high price levels. But for this fact the figures for the volume of metallic tin sent from Portugal to Germany would have been most surprising. Previously only a small proportion of the ore mined in Portugal was smelted there. The only substantial smelter in the country, prior to 1940, was that installed at Belmonte by the American company which works the Portuguese-American Tin Company's dredger in the Gaia Valley. The company has about 1000 acres, including workable stanniferous deposits averaging a depth of 20ft. Despite ease of working, the exportable output has never been large; 86 tons of metal were shipped to the U.S.A. in 1940 and only 10 tons in 1941. Development of the smelting side of the industry in the war years has enabled Portugal not only to start providing for home requirements, but to export about 1200 tons of tin a year. In addition to the 546 tons that went to Germany in 1941, some 611 tons went to Italy and others of Germany's satellites. Germany's normal consumption in peacetime amounted to 12,000 tons a year."

The Pig Iron Market

The pig iron position generally is comparatively easy, with the exception of hematite pig iron. The production of this make is still handicapped by the shortage of suitable ore, in spite of arrivals of high-grade ore from North Africa. These have been restricted by war conditions, but it may be expected that supplies will increase in the not distant future. The heavy engineering and allied foundries, which are mostly engaged upon Government work, are now able to obtain practically all the low and medium-phosphoric pig iron they require. This is due to the increased production of these descriptions; but, at the same time, there has been a decline in the demand, principally because of the changes in the war production programme. A large proportion of the engineering foundries, however, are fully employed on castings for machine tools, tanks, and other armaments, and the managements are now largely relieved of pig iron supply difficulties. The hematite position is difficult and will remain so until there is a noticeably larger output. The demand, on the other hand, shows no signs of declining, and there is a considerable use of substitutes in the shape of refined and low-phosphorus iron. The light castings foundries, although on the whole better engaged than for a long time, are working well below capacity and are able to obtain all the high-phosphorus iron they want. The production of this pig iron is on a big scale, and larger quantities are being used by heavy engineering foundries than in normal times. There is no lack, also, of forge pig iron, which is in moderate demand, although recently a rather more active trade has ruled in this description. The great activity at the steel works ensures a heavy demand for basic pig iron, but production has been well maintained and the steel works are getting full supplies of this description. A satisfactory feature of the pig iron position is that, with the exception of high-class ore suitable for the production of hematite, the raw materials position is excellent. Large supplies of furnace and foundry coke are available and most consumers appear to have sufficient stocks to enable them to limit their fresh purchases to meet their current needs. Supplies of limestone, also, have increased recently and at the moment appear to be somewhat in excess of the demand. In the ferro alloy department there has been a strong demand for ferro-titanium, which appears to be gradually increasing.

Scotland and the North

The relaxation in the demand for certain steel products and the increased call for others resulting from changes in the Government's armament programme have been met without difficulty by the Scottish iron and steel industry, but it is now expected that further changes may be made in the war programme arising chiefly from alterations in the activity of the shipbuilding industry, due to greater emphasis being laid on the production of certain types of vessels. There is little doubt, however, that the industry will make necessary changes without difficulty, and the probability is that the total volume of the demand for steel will not be materially affected. The huge plate requirements of the shipyards are likely to be maintained whatever changes are made. The plate mills have been working at capacity for a long time and recently there have been some delays in deliveries owing to temporary transport difficulties. Not only are the plate mills working at capacity, but the sheet mills have been turning out large quantities of light plates and have been subjected to continuous pressure for delivery. It is difficult now to place orders for any kind of plates for delivery before Period I in next year, and in some cases much later. The time required for delivery of sheets under 3 mm. has lengthened and there is a steady and heavy demand from the shipyards which are using these sheets for fittings for which formerly wood was used. Whilst there is a heavy demand for structural steel it is confined chiefly to the lighter sizes, and there have been no indications of any improvement in the call for heavy joists and sections. The re-rolling industry is carrying heavy order books for lighter structural sections, small steel bars, &c., and the works, almost without exception, are booked well into next year. Other departments of the Scottish iron and steel industry, including the tube makers, are fully employed. In Lancashire the changes recently made in the Government's war production programme have had little effect upon the total output of steel, and what loss there was in certain directions is expected to be made good when the necessary reorganisation has been completed. The demand for nickel steel and alloy steel generally has increased somewhat during the past few weeks. Generally speaking, consumers have not found it difficult to place orders for the required delivery—an indication that the situation is much easier than even a short time ago. The plate position also, although the demand from the shipyards, locomotive builders, and wagon builders does not seem to have decreased, has shown signs of easing of late, and shorter delivery dates than consumers have been accustomed to have been quoted in a number of instances. There is an important volume of business passing in steel bars and delivery dates are somewhat prolonged. The volume of business in the finished steel products produced at the works on the North-West Coast is well maintained. The demand is almost entirely associated with the war effort, and there is sufficient work in the hands of the mills to keep them fully employed for several months.

The North-East Coast and Yorkshire

The general position in the finished steel department has not changed for several weeks. The steel makers on the North-East Coast have undertaken commitments which will keep them working practically at capacity to the end of the year. It is almost out of the question to place any orders for delivery in the current period unless they are of the urgent priority class. Many of the works have also undertaken substantial orders for delivery in the first quarter of 1944. The great improvement in the flow of semi-finished material to consumers has been well maintained, although deliveries have been interfered with in some districts by transport congestion. The re-rollers have heavy orders on their books for small bars and light sections and are taking up big tonnages of billets and sheet bars. The production of semis is now on such a scale that withdrawals from stocks of imported material held by the Control have practically ceased. At the same time, re-rollers are using considerable quantities of defective billets, double-sawn crops, &c. The principal feature of the finished steel trade remains the insatiable demand for plates. These are taken in large quantities by the shipbuilders, boilermakers, locomotive and wagon builders. The requirements of these industries come within the essential categories, and to meet the demand the plate mills have to work at capacity. Many of them have accepted orders for delivery over the first half of 1944. There is little demand for heavy joists, but a considerable volume of business is passing in light and medium sections. No change of importance has occurred in the Yorkshire steel industry recently. Production has been raised to a high level, and although the pressure for supplies of all descriptions of steel is intense, deliveries have been maintained at a satisfactory rate. Great activity rules in the basic steel department and it is unlikely that any change of note will occur in this section of the industry for an indefinite period. In the acid carbon steel department also the demand has shown no sign of declining. The engineering industry is calling for large supplies of alloy steels, although the position in this section is easier than it was twelve months ago. There is a brisk business also passing in corrosion-resisting steel. The works producing forgings and drop forgings are fully employed.

The Midlands and South Wales

Although there has been no decline in the activity at the Midland iron and steel works, pressure from consumers for supplies has not been so noticeable as it was in the second quarter of the year. The works are not likely to be in a position to relax their efforts to maintain production for the remainder of the fourth period, since they are well supplied with orders, and it is anticipated that the allocations which will be issued at the end of December for the first delivery period of 1944 will be sufficient to keep them fully employed during that period. There is still a strong request for alloy steel from aircraft makers, armaments and munition works, and supplies to these industries have been well maintained. In fact, recently the delivery dates for alloy steel have in some cases shown a tendency to become shorter. The works producing plates are employed at capacity and have not been able greatly to reduce the heavy commitments they have undertaken for the shipbuilders, locomotive and wagon builders. The re-rolling works are receiving good supplies of semis, and this branch of the industry is operating practically at capacity. The orders in hand will keep them busy well into next year and consumers are exercising considerable pressure to obtain delivery. In some cases re-rollers find their books congested with orders for small steel bars and light sections, but the demand for strip is comparatively light. Many re-rolling works have been heavily committed to the manufacture of mining equipment, including sections, arches, and light rails. The South Wales steel industry is operating at full capacity, and it is difficult to find a works able to undertake orders for delivery until the first delivery period in 1944. The production of semis in Wales is on a heavy scale. The volume of business in sheet and tinplate bars absorbs all the steel allocated for this purpose, whilst there is a large production of billets. The tinplate market has been rather more active recently. The improvement has been chiefly noticeable in the home trade and consumers have placed orders for delivery for the remainder of this year and for the first quarter of next year. There has been no improvement in the export market, which remains idle.

Iron and Steel Scrap

For a long time now the demand in the iron and steel scrap market has been principally for supplies of the heavier and better qualities of scrap and the position has gradually become tighter. Lately the stringency seems to have become accentuated and consumers have had to devote more attention to acquiring other grades less suitable for their purpose than the ones they have hitherto relied upon. This has resulted in important withdrawals from the stocks of lighter material which had been accumulated at many of the consuming works. The demand for good heavy mild steel scrap cut to furnace and foundry sizes is still a strong feature of the scrap market, and the distribution of this description is carefully regulated. Bundled steel scrap and hydraulically compressed steel shearings are being actively taken up. There is not much change in the position of mild steel turnings. These are arising in considerable quantities, and good heavy and chipped varieties are finding a ready market; but other descriptions of this class are in poor demand. Mixed wrought iron and steel scrap for basic steel furnaces is in strong request and substantial quantities are passing into consumption. Some stringency is noticeable in the good heavy material and consumers are showing nervousness as to the position.

Notes and Memoranda

Air and Water

A 5000-TON CONCRETE BARGE.—An ocean-going concrete barge was launched at the end of August by the San Jacinto Shipbuilding Company, Port Neches, Texas. The vessel is 366ft. long, 45ft. deep, and has a beam of 54ft. The gross tonnage is 5150.

RECORD FLIGHT.—A 3100-mile non-stop flight from Montreal to a British airport was made early in the week by Captain Richard Allen in 11 h. 35 min. The flight, which beat all long-distance and trans-atlantic air speed records, was made in a "B.24 Liberator" on the R.A.F. Transport Command's North Atlantic shuttle ferry for the British Overseas Airways Corporation.

SWEDISH SHIPPING LOSSES.—Official figures relating to war losses of the Swedish Merchant Marine up to the end of September of this year show that 224 vessels with an aggregate tonnage of 567,720 gross tons were lost. In these figures are included twenty-five merchant vessels of 46,000 tons seized by the German Prize Court and seventeen fishing vessels of 894 gross tons.

THE GANDY BRIDGE, FLORIDA.—The State Road Department of Florida, U.S.A., wants to acquire for the State the Gandy bridge and the Davis causeway across Tampa Bay, but the principal stockholder and president of the owning company has declined to offer the span for sale. Litigation by the State to acquire the bridge by condemnation might require years, but condemnation proceedings may be brought by the Federal Government under its war powers.

CANADIAN AIRPORT CONSTRUCTION.—Mr. C. R. Patterson, President of the Aeronautics Institute of Canada, stated in a recent address in Toronto that plans are in hand for the post-war construction of landing strips and airports in the smaller cities, towns, and villages across the Dominion. These airport projects, Mr. Patterson said, would be carried out by local enterprise, with a minimum drain on the Dominion Treasury. They would absorb a considerable number of trained air personnel, artisans, and other service workers and would bring the remotest parts of Canada within sixty hours' flying time of all parts of the world.

COASTAL SHIPPING AND AIR TRANSPORT.—We are informed by the Chamber of Shipping of the United Kingdom that shipping companies which have previously been engaged in U.K. coasting liner trades and in U.K./Continental trades have agreed to form a separate company to operate passenger and cargo air services over internal and Continental routes to be established. The intention is to put this plan into operation as soon as the necessary consents and machines can be obtained. The capital of the new company will be subscribed by the various shipping and other transport interests.

Miscellanea

BRIDGE DESIGN AWARD SUSPENDED.—The American Institute of Steel Construction announces that, due to the effect of conditions brought about by the war emergency, it has been decided to suspend its Students' Annual Bridge Design Competition until the war has ended. This has hitherto been one of the most popular of American competitions for young engineers.

BUILDING A TOWN IN NINETY DAYS.—Americans are claiming a record in town building. Vanport City, in Oregon, covers 650 acres, and consists of 703 apartment buildings and 17 multiple-dwelling structures, totalling 9942 units, with 181 service annexes and 45 special public and service buildings—all built in ninety days. This giant war project will shelter 40,000 residents, and will occupy fifth place in population among the cities of the U.S. North-West and second in Oregon. Salem, Oregon's capital and formerly second city in size, needed nearly a century to attain a population of 30,000.

GUIDE TO QUALITY CONTROL FOR ENGINEERS.—A new handbook, "A First Guide to Quality Control," compiled by the Ministry of Supply Advisory Service on Quality Control, has been recently published and is being issued free to those interested. It aims to provide a set of rules for engineers who have not the time to study the full theory of statistical control, but wish to avail themselves of its advantages in their own factories. Very few explanations are given, the procedures being simply set out step by step and illustrated by numerous examples collected from actual factory experience. Chapter I sets out the procedure to be adopted when putting in the first control chart in a factory. Chapter II gives instructions as to the interpretation of the chart when plotted. Chapter III deals with quality control in full operation. Chapter IV describes a method of quality control specially designed to suit production on multi-spindle automatic lathes. Chapter V gives a brief sketch of the general type of control chart suitable for inspection by go and not-go gauges and describes the Bell Telephone system of double sampling. In an appendix the mathematical derivations of the various factors and criteria used in the book are briefly sketched.

THE "CONSTRUCTIVE INDUSTRY."—What is described as a "good-natured disagreement" in official and labour circles in Canada has been settled after years of controversy. In future the term "constructive industry" is to include "all work directly applicable to the construction, renovation, alteration, repair, or demolition of any building, interior fitting, railway, tramway, harbour, dock, pier, canal, inland waterway, irrigation or water conservation system, road, tunnel, bridge, viaduct, sewer, drain, telephonic, telegraphic, or electrical undertaking, gas work, pipe line, water supply systems, or any such works, but will not include work performed by the regular maintenance staff of an employer."

Personal and Business

SIR EUSTACE PULBROOK has been re-elected chairman of Lloyd's.

MR. J. CALDERWOOD has been elected Chairman of the Junior Institution of Engineers.

MR. J. H. W. CHIVERS has joined the board of Houghton-Butcher Manufacturing Company, Ltd.

THE MINISTER OF FUEL AND POWER announces that Dr. H. S. Houldsworth, K.C., has accepted his invitation to become Controller-General of the Ministry from the beginning of next year.

MR. WILFRID AYRE and Mr. E. Bruce Ball, jun., have been appointed to a committee formed by the Secretary of State for Scotland to advise the Advisory Council of Education on trade and technical education.

THE LONDON PASSENGER TRANSPORT BOARD announces that Mr. H. J. Green, M. Inst. C.E., is relinquishing the position of chief engineer (civil) for health reasons. Mr. P. Croom-Johnson, M. Inst. C.E., chief stores superintendent, will succeed him.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, Dec. 6th.—Technical College, Bradford. "Lighting in the Woollen and Worsted Industry," J. W. Howell. 6.45 p.m.

British Association of Refrigeration

Thursday, Dec. 16th.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Discussion, "Domestic Refrigeration." 5.30 p.m.

Engineer Surveyors' Association

To-day, Dec. 3rd.—GLASGOW BRANCH: Inst. of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "High-Speed Lifts," F. H. Rothwell. 8 p.m.

Illuminating Engineering Society

Tuesday, Dec. 14th.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Discussion, "Street Lighting Specifications of the Future." 5 p.m.

Institute of British Foundrymen

Saturday, Dec. 4th.—LANCS BRANCH: Engineers' Club, Albert Square, Manchester. "Modern Core-Sand Practice," J. G. A. Skerl. 3 p.m.—LINCOLN SECTION: Technical College, Lincoln. "Some Work of the Technical Committee in Wartime," J. W. Gardom. 3 p.m.

Saturday, Dec. 11th.—BRISTOL BRANCH: Grand Hotel, Bristol. "Light Alloys *versus* Ferrous Founding," J. Roston. 3 p.m.—E. MIDLANDS BRANCH: Technical College, Derby. "Cupola Theory and Control," R. C. Tucker. 3 p.m.—SCOTTISH BRANCH: Royal Technical College, Glasgow. Short Paper Competition. 3 p.m.—YORKS BRANCH: Technical College, Bradford. "Some Foundry Problems," H. Balme. 6.30 p.m.

Institute of Fuel

Wednesday, Dec. 8th.—Connaught Rooms, Great Queen Street, W.C.2. "The Production and Use of Open-Cast Coal," K. C. Appleyard. 2.30 p.m.

Institute of Transport

Saturday, Dec. 11th.—METROPOLITAN GRADUATES: Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Organising the Road Transport Industry," C. F. Klapper. 2.15 p.m.

Tuesday, Dec. 14th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Annual general meeting. 2.30 p.m.

Institution of Automobile Engineers

Sunday, Dec. 12th.—LONDON GRADUATES: 12, Hobart Place, S.W.1. "The Two-Stroke Diesel Engine," by "An American Engineer." 3 p.m.

Institution of Chemical Engineers

Tuesday, Dec. 14th.—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Petroleum as a Base Material for Chemical Industry," J. G. C. Boot. 2.30 p.m.

Institution of Civil Engineers

Saturday, Dec. 4th.—BIRMINGHAM ASSOC.: Watt Memorial Institute, Great Charles Street, Birmingham. "Preliminary Works for the Irrawaddy Bridge," G. G. T. Toller. 2.30 p.m.

Tuesday, Dec. 7th.—RAILWAY ENGINEERING DIVISION: Great George Street, Westminster, S.W.1. "Soil Mechanics and the Railway Engineer," H. R. Reynolds, and "Some Soil Mechanics Problems on the L.M.S. Railway," M. F. Barbey. 5 p.m.

Tuesday, Dec. 14th.—ROAD ENGINEERING DIVISION: Great George Street, Westminster, S.W.1. "The Alcan Highway," S. A. McMillion. 5 p.m.

Institution of Electrical Engineers

Monday, Dec. 6th.—S. MIDLAND CENTRE: Watt Memorial Institute, Great Charles Street, Birmingham. "The Economic Rating of Motors and Transformers," and "The Economic Flux Density in Large Transformers," D. J. Bolton. 6 p.m.

Wednesday, Dec. 8th.—TRANSMISSION SECTION: Savoy Place, Victoria Embankment, W.C.2. "The Problem of Conductor Sagging on Overhead Transmission Lines," C. O. Boyse and N. G. Simpson. 5.30 p.m.

Thursday, Dec. 9th.—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. "Industrial Fire Risks," W. Fordham Cooper and F. H. Mann. 5.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Dec. 7th.—39, Elmbank Crescent, Glasgow. "Gravity Die Casting in Non-Ferrous Alloys," E. H. A. Carlton. 6.30 p.m.

Institution of Mechanical Engineers

To-day, Dec. 3rd.—APPLIED MECHANICS GROUP: Storey's Gate, Westminster, S.W.1. "On the Stresses in Hooks and their Determination by Relaxation Methods," L. Fox and R. V. Southwell. 6 p.m.

Saturday, Dec. 4th.—WESTERN BRANCH: Merchant Venturers' Technical College, Unity Street, Bristol. "Remember the Past and Look to the Future," Professor F. C. Lea. 2.30 p.m.

Tuesday, Dec. 7th.—S. WALES BRANCH: Mackworth Hall, Swansea. "Remember the Past and Look to the Future," Professor F. C. Lea. 3 p.m.

Friday, Dec. 10th.—Storey's Gate, Westminster, S.W.1. "A Survey of Plastics from the Viewpoint of the Mechanical Engineer," S. Livingston Smith; and "Moulding Plant for Plastics," J. L. Daniels. 5.30 p.m.

Institution of Production Engineers

To-day, Dec. 3rd.—LINCOLN SECTION: Technical College, Lincoln. "Training of Machine Tool Operators," F. J. Keeble. 6.30 p.m.

Iron and Steel Institute

Saturday, Dec. 4th.—Royal Victoria Station Hotel, Sheffield. Fourth Report of the Oxygen Sub-Committee. 2.30 p.m.

Junior Institution of Engineers

To-day, Dec. 3rd.—39, Victoria Street, S.W.1. "Some Elementary Aspects of Geology," N. S. Aston. 6.15 p.m.

Friday, Dec. 10th.—39, Victoria Street, S.W.1. "The American Methods of Ship Construction as Examined by a Delegation of British Shipyard Workmen," H. S. Ratcliffe. 6.15 p.m.

Saturday, Dec. 11th.—MIDLAND SECTION: Watt Memorial Institute, Great Charles Street, Birmingham. "The Synchrophone as an Aid to Post-War Training," N. Sandon. 2.30 p.m.

Keighley Association of Engineers

Friday, Dec. 10th.—Victoria Hotel, Keighley. "Producer Gas Plants for Transport Vehicles," S. S. Benson. 7.30 p.m.

London Association of Engineers

Sunday, Dec. 5th.—Curzon Theatre, Curzon Street, W.1. Film, "Forgings in Hiduminium - Aluminium Alloys." 3 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Wednesday, Dec. 8th.—STUDENT SECTION: Bolbec Hall, Newcastle-upon-Tyne. "Production of Marine Gearing for Merchant Ships," W. T. Atkinson. 6.45 p.m.

Royal Aeronautical Society

Wednesday, Dec. 8th.—GRADUATE SECTION: 4, Hamilton Place, Piccadilly, W.1. "Gliders and Gliding," K. G. Wilkinson. 7.30 p.m.

Royal Society of Arts

Wednesday, Dec. 8th.—John Adam Street, Adelphi, W.C.2. "Some Modern Methods of Construction Practised in America," A. C. Bossom. 1.45 p.m.